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LIGHT ⁘ HEAT ⁘ POWER ⁘ BYE-PRODUCTS

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Editorial Notes.

Juniors at a Senior Meeting.

ALL those who know Mr. W. B. McLusky, of Halifax, are aware of the encouragement and help which he gives to the junior members of the gas profession; and to us it came hardly as a surprise that during his year as President of the Manchester District Institution of Gas Engineers he should express his ideas tangibly and to good purpose. At the meeting of the Institution last Friday two Juniors—Mr. H. Platt, of Bolton, and Mr. Leslie S. Pickles, of Halifax—contributed papers of excellent technical standard, and the discussions which they evoked were indication of the interest they aroused.

The paper by Mr. Pickles lent itself to discussion far more readily than did that of Mr. Platt. The latter dealt with the loading stresses on earthworks and tanks, which is admittedly a specialized subject. Mr. J. H. Clegg suggested that more attention should be paid to constructional engineering in the Education Scheme of the Institution of Gas Engineers; but to our mind such a course would be at the expense of what may loosely be termed the mechanical side, and would not offer such a good return. We agree, however, that more attention should be given to it generally than at present, if only for the reason that gas-works structures become more concentrated and more massive. Mr. Platt speaks of concrete piles cast *in situ*, and both in the paper and during the discussion this method of piling was regarded in favourable light.

It is, however, to the contribution by Mr. Pickles—who incidentally was last year's Institution Diplomé—that we wish particularly to refer. Following a review of past and present methods of wet purification of coal gas, the author describes experiments carried out at the Halifax Gas-Works in an endeavour to minimize the effluents difficulty and to render treatment of ammoniacal liquor a better paying proposition. The idea is to spray the gas in the hydraulic main with a dilute solution of sulphuric acid, and afterwards to wash the gas with alkali. The former treatment, it is stated, removes the entire ammonia content, the latter hydrocyanic acid, cyanogen, and about half the sulphur compounds. Higher tar acids and thiocyanate are not present in the acid liquor, and the phenol and thiosulphate contents are materially less than in alkaline liquor. Moreover, the phenol in the acid liquor is "free," capable of being removed by simple steam distillation or recoverable as a marketable product by benzole washing. "Pyridine bases" show an increase, but are readily removed or recovered. Regarding this, we commented on the Pott-Hilgenstock process in our columns a few weeks ago, mentioning that benzole washing removes pyridines and other tar bases, and 90 p.ct. of phenols on a commercial scale. Mr. Pickles is so impressed with the idea that he expresses the opinion that separate pyridine recovery might be a sound financial proposition. Mr. R. H. Clayton, however, does not share this optimism. His inspection of the benzole washing of liquor in Germany led him to the conclusion that the process is applicable only to very large installations, and that not all liquors are amenable to treatment. Moreover, the market for pyridine is very limited.

The author cites other advantages of the acid liquor process. Alkali washing would remove one of the greatest corrosive agents from the gas; it would give a double function to the hydraulic main, saving the capital cost and maintenance charges of wet purification plant; it would effect great economies in the oxide purification process. He states that "sufficient data have been obtained to prove the theory of the method and to suggest that its commercial application would result in extensive financial gain." The first thought which will doubtless occur to our readers will be the corrosive effect of dilute sulphuric acid on the ironwork. Mr. Pickles states that the tar film on the interior of the hydraulic main and connecting pipes protects the iron from this action of the acid. One has to remember, however, that the experiment lasted only two months, and that it was on a small scale; otherwise his figures for the iron content of the liquor would be more convincing. We think that our doubts on this matter will be shared by many of our readers.

Mr. Clayton pointed out that cyanogen recovery by alkali washing is not a paying proposition—that the English market only requires 1000 tons of prussiate per annum. He also suggested that the effect of hydrocyanic acid on ironwork is not to be feared unduly, though its corrosive action on the copper and nickel alloys used in meters is serious. In any case he regards it as preferable to remove the cyanogen compounds in the oxide boxes. Other speakers referred to the large volume of acid liquor produced, to the difficulty of carbon dioxide in the final gas, and to the disadvantage of absence of ammonia in gas as it passed to the oxide purifiers. Until further figures are adduced, and other means which are now being explored are developed, the conclusions set out by Mr. Pickles cannot therefore be regarded as a working solution to effluents problems. Our present idea on the matter is that much can be achieved by the smaller gas-works making a stronger liquor and transporting it to a central distillery. This idea will undergo modification when sufficient proof is forthcoming that other methods than the alkaline liquor treatment are generally advantageous. As yet we cannot see this proof clearly, but this does not in the least interfere with our interest in studying the paper by Mr. Pickles, or with our opinion that it is an exceptionally valuable contribution. Certainly both papers at the meeting of the Manchester District Institution fully justify the faith of Mr. McLusky in the juniors, and his desire to assist them in the work they are doing for the industry.

Coke Oven Gas for Town Supply.

In these columns a few weeks ago we stated that reliability of supply has to be taken into account when gas authorities are arranging to purchase coke oven gas, and that it has the monetary effect of depreciating by almost one-half the price which gas undertakings might otherwise offer the coke oven gas suppliers. Plant to cover the full amount of coke oven gas delivered has to be provided at the gas-works and maintained in a condition ready for immediate operation, and staff must be available. The necessity for this is shown by Mr. C. F. Blincoe, of Middlesbrough—the first gas concern in England to utilize coke oven gas for domestic supply, and still the largest undertaking whose whole output consists solely of coke oven gas—in his Presidential Address before the North of England Gas Managers' Association. Since 1918, the coke oven supply has been curtailed, or suspended altogether, three times; the periods over which the deficiencies occurred varying from two weeks to nine months.

Apart entirely from the cost of providing a nucleus staff, the annual costs of repairs and maintenance of works at Middlesbrough over the fifteen years during which the scheme has been in operation have varied from 1·53d. to 6·56d. per 1000 c.ft. of gas sold, with an average of 3·21d.; and all who study Mr. Blincoe's remarks must come to the conclusion that this figure represents the most efficient and economical course which could have been taken in the circumstances. The stand-by plant consists of three sets of carburetted water gas plant (4½ million c.ft. per day) and an inclined retort installation (1¾ million c.ft.). There can be no doubt that a combination of water gas and coal gas in the ratio of 4 to 1 is a sound proposition, for it conserves the available coal supply. The entire coke produced in the retort house can be used in the water gas plant.

Mr. Blincoe recounts the trouble he experienced due to deposition of naphthalene in the main connecting the coke oven plant with the gas-works, and how he remedied a position which at one period became critical. His story demonstrates how necessary it is that all agreements for the purchase of coke oven gas should contain a clause imposing a limitation on the naphthalene content of the gas. The agreement between the Nunnery Colliery Company and the Sheffield Gas Company, published in the "Journal" for Oct. 12, 1927, incorporates a clause that the naphthalene shall not exceed 2 grains per 100 c.ft. It has to be remembered, of course, that this quantity of naphthalene in coke oven gas has greater ill-effect than the same amount in unscrubbed coal gas. Mr. Blincoe mentions that at one period an attempt was made at the coke oven plant to extract the naphthalene from the gas by scrubbing with benzolized creosote. "This improved the conditions in the coke oven main, but brought about great trouble in the distribution system." It would have been of value had the author given his views on this problem of cause and effect; we cannot think that the cause of the district troubles was the scrubbing at the coke oven plant.

Other matters discussed by Mr. Blincoe include the method he adopted to counteract oxide acidity in the purifier boxes, by the use of a top layer of soda ash, and the benefits which can be derived from the adoption of the back-run process in water gas plants.

Low-Temperature Carbonization.

The "Journal" last week contained a full account of four of the low-temperature carbonization plants which are operating on a commercial scale in London Gas-Works: The "K.S.G." plant at the Greenwich Works of the South Metropolitan Gas Company, the "Salermo" unit at the Fulham Works of the Gas Light and Coke Company, and the Fuel Research Board and Hird plants at the Richmond Works of the latter Company. These processes were inspected by members of the Institute of Fuel, who afterwards discussed the progress made in low-temperature carbonization as exemplified by the plants in question.

The discussion yielded very little on which to base an opinion as to the ultimate financial success of the various systems, but it clearly indicates the great amount of experimental development which has taken place during the past two years. The experiments have not plunged the inventors of the processes into gloom; so much is obvious from the replies to the points raised at the meeting. It is equally obvious that they have had a chastening effect, for the replies were a veritable model of caution and restraint. It seemed as though the inventors were conscience-pricked by over-optimism in the past on the part, not necessarily of themselves, but of low-temperature advocates generally, and were anxious to create a feeling of confidence among a body of technologists. They undoubtedly succeeded in demonstrating that they are working on scientific lines and are effecting many improvements in the technique of low-temperature carbonization. To what extent this attitude is attributable to proximity with the gas industry, we do not know; but we do know that the industry has shown broad-minded enterprise and has given the lie to the all too frequent statements that it is out to stultify the development of low-temperature carbonization.

The discussion showed that the time is not yet ripe for an announcement that any of the plants inspected is a clear financial success. To date, their operation has brought to light either excessive labour and fuel costs or constructional difficulties. It may also have provided remedies, but we have to await substantial proof of this. Our critics will perhaps remark that once again we are harping on the same old string—that low-temperature carbonization is still, speaking broadly, in an experimental stage as far as this country, at any rate, is concerned. Alas, we are unabashed, for it has yet to be recognized that fancy prices must not be fixed for the products of the low-temperature process, that in very few systems it is possible to obtain ammoniacal liquor which is usable, and that this liquor may, indeed, constitute a direct loss of revenue. For example, the liquor produced by the Fuel Research Board plant has a strength of from 3 to 5 oz.

Dr. C. H. Lander, Director of Fuel Research, took the opportunity of pointing out the objects of the experiments with the Fuel Research Board plant at Richmond. The plant is not regarded as in any way competitive with any other system in the world; it is guarded by no patent; it will probably die a natural death very soon. The whole idea is to obtain data calculated to be of service to others in the field. There may be those who regard the experiment as being a trifle costly, but it is too early to dogmatize on this point. We call to our aid once again a little patience; but after the meeting which is the subject of this note we are left with the conviction that those responsible for the plants described in last week's "Journal" are placing the just value on reliable figures, and we share the thought expressed by the Chairman of the meeting, Sir William Larke, that the greatest encouragement he had derived from the discussion was the knowledge that the inventors had promised to publish their working results as soon as reliable figures were obtained.

Testimony of the Red Disc.

The question of the safety—or, it would better be said, the danger—of the streets under present vehicular traffic conditions has of recent months been mentioned on more than one occasion in our pages; and the matter is brought again to mind by the issue of the second Traffic Advisory Committee report on street accidents in Greater London. The gravity of the street accident problem has rendered it a subject of general public concern; but even now it is difficult to get focussed upon it the amount of attention which is essential if any real good is to be achieved. Figures—terrible as in this case they undoubtedly are—when expressed baldly, do not make the strongest appeal to the imagination, except of those who are accustomed to dealing with them. Illustrations are far more effective in this respect—pictures, if possible, or graphs.

The Traffic Advisory Committee include in their report a table showing the numbers of persons killed in street accidents in Greater London (the Metropolitan Police District) for each of the years from 1920 to 1928; and the information it conveys is that the fatalities have, within this brief period, practically doubled. That is to say, in

1920 the deaths numbered 657; and in 1928, 1252. In the nine years, 7668 persons have been killed. During the same time, the number of people injured (not fatally) has far more than doubled; the figures having risen from 21,028 in 1920 to 55,381 in 1928. These increases are, of course, out of all proportion to the increase that has been taking place in the population. Consider the year 1921—with an estimated population in Greater London of 7,535,582, one person was killed out of every 12,970, and one was injured out of every 322. By 1927, the estimated population had risen to 7,809,963, but one person was killed out of every 7292, and one out of every 159 was injured. While the number of accidents can have no direct relationship to the population figure, these comparisons are highly significant, and emphasize the fact that the whole matter calls for most earnest consideration.

As we have said, however, a bare narrative of figures is not the best way of securing general attention; and a far better one is to be found in the Committee's report. At one time they contemplated the issue of a map for distribution to local authorities and other interested parties indicating all the points in Greater London at which fatalities had occurred; but unfortunately difficulties were encountered, as it was found impossible to give clear indications except on large-scale maps. As an alternative, therefore, they have attached to their report a 6-in. scale map showing, by means of red discs, the points at which fatalities have occurred in Central London during the years 1920 to 1928. As this is naturally the area in which most of the accidents occurred, it is believed by the Committee that it will serve the purpose aimed at—that of giving all the authorities concerned, as well as the general public, a graphic illustration of the dangers of the streets. No one who sees the map will for another instant doubt the vital necessity of taking further steps to counteract this growing menace. The local authorities will find in it convincing testimony; and we could only wish there were some means of placing the map in the hands of the public at large. Blue Books, however, enjoy a smaller measure of popularity than they deserve, largely because their contents usually cannot be mastered without an effort; and so this map, whose message can be read at a glance, is unlikely to find its way into the hands of the "man in the street," be he driver or pedestrian.

Good Street Lighting Essential.

THAT the Traffic Advisory Committtee are fully alive to the situation is evidenced by their opinion that extensive and sustained propaganda work is necessary for the education and warning of all classes of road users. Their consideration of the problem of street accidents leads them to believe that the principal means of reducing the number lie in this direction; but the work of the public lighting engineer must also be of the utmost importance. The Committee have been not unmindful of the vital part played by good street lighting in securing the greater safety of the streets; for their report of 1927 contained recommendations: "That the authorities concerned "should give immediate consideration to the question of "whether arrangements could be made for the adoption "of a uniform system of lighting the more important "thoroughfares within (say) the Administrative County "of London; and that the Highway Authorities and "Lighting Authorities concerned should give immediate "consideration to the question of the lighting of im-"portant road junctions and roads on which there is heavy "night traffic." They now again urge the authorities to give further consideration to the question of improving the street lighting, and providing additional lighting at dangerous road junctions. It is acknowledged that where bad lighting has been a contributory factor to accidents, the local authorities concerned have usually readily complied with the suggestions of the Commissioner of Police; but the seriousness of the situation is laid bare by the following statement which appears in the report: "In "our investigations into the problem of street accidents, "we have been impressed by the fact that insufficient "street lighting appears to be responsible for a large "number of accidents; and while we have not com-"pleted our inquiries into this aspect of the problem, "we think the attention of the local authorities should be "drawn, first of all, to the desirability of aiming at a "uniform lighting standard, and, secondly, to the stan-"dard recommended by the British Engineering Stan-"dards Committee."

The public lighting engineer has, indeed, a great part in this life-saving movement; but the responsibility for the efficient carrying-out of his duties must rest with those in whose service he finds himself. Good public lighting is expensive; and where members of local authorities regard the question first from the financial point of view, the efficiency of the street lighting is likely to suffer. We have maintained before—and this report supports the contention—that the principles involved are not such as should be governed primarily by considerations of pounds, shillings, and pence. A number of places shown on the map of Central London already referred to indicate a noticeably high average of fatalities in proportion to their length—for example, Charing Cross, Camden Town High Street, and the Victoria Embankment. Even though they are admittedly dangerous traffic areas, if this is the case where so much attention has been devoted to public lighting, what can be hoped for under conditions of lower efficiency?

Road Re-Instatement.

BEFORE leaving this graphic report of the London and Home Counties Traffic Advisory Committee, there is one further point to which attention should be drawn, though we hope, and believe, that it has little application to the gas industry. Responsibility, however, rests somewhere, for the Committee state that the failure of statutory undertakers to fill in excavations properly after laying water, gas, and electricity services is still responsible for an appreciable number of street accidents. It is admitted that such accidents are decreasing; and the time should arrive when it will be impossible for the Committee to remark, as they do in the present report, that "it is obvious that sufficient care is not always exercised to ensure that the re-instatement of the road surface is carried out and maintained in a proper manner." This desirable state of affairs can be reached only by perfect co-ordination between highway authorities and statutory undertakers.

Institution Education Scheme.

Full particulars of the revised Education Scheme of the Institution of Gas Engineers have now been published in booklet form; and any communications regarding the new regulations should be addressed to the Organizing Secretary, at 28, Grosvenor Gardens, S.W. 1. It is stated that, where candidates find it impossible to take advantage of a course at an approved centre, they may take the examination for both Ordinary and Higher Grades as external students. Upon request, the Organizing Secretary will forward a copy of the detailed syllabus for the Examining Body undertaking the examinations in the area in which the student resides.

Licensed Houses—And Directors.

In last week's issue of the "JOURNAL" we mentioned a few small alterations in company administration which it seemed to us would do something to safeguard the investor; but at a meeting of the Law Society, a Solicitor has gone much farther than we did. He made the following suggestions: Every director should be compelled to state in the prospectus whether he was experienced, especially in the business which he proposed to "direct." Indeed, he said, it would be preferable to license all directors, so that an unlicensed person should be incapable of acting. No underwriting should be allowed to be referred to in the prospectus until the underwriters had deposited with the company's bankers the amount due on application and allotment on the shares they were underwriting. Every issuing house should be licensed by the Board of Trade, and should be compelled to make a substantial deposit to answer claims, in the same way as life insurance companies. There should be a department of the Board of Trade

charged with the duty of enforcing the penalties laid down by the Act. The Board of Trade should be empowered to appoint a department to inquire where there were frequent complaints regarding a particular company—such department having power, where necessary, to suspend the Board, and to appoint in their place interim managers. No prospectus should be issuable without approval of the Registrar.

Good Example of Dublin.

A remarkably good showing is made by the Alliance and Dublin Consumers' Gas Company for the first half of the present year. An increase of more than 8 p.ct. in the sales of gas has been secured by means of the addition of nearly 3000 to the number of consumers. The latter figure would be gratifying in any case, but it is particularly so in view of the fact that it is considerably more than the number of new houses which came into occupation under the various housing schemes. More significant than all, however, is an increase in the average consumption per consumer—a feature which is especially noticeable in the case of ordinary meter users. Such statistics as these, taken in conjunction with the large number of extra gas-consuming appliances placed on the district in the period under review, are peculiarly welcome at the present time, when so much of the "boost" is on the "other leg."

The Way to Prosperity.

The case of Dublin, cited above, shows that much opportunity still remains in connection with the domestic load; but the industrial load, in many places, undoubtedly offers even greater scope. In a paper presented at a coal smoke abatement conference during last week-end (and reproduced in this issue), Mr. Samuel Tagg, Engineer and Manager to the Preston Gas Company, was able to put the case for gas in industry upon such a plane as to justify fully his claim that, under present conditions, there is in this direction a wide potential market as yet undeveloped, and that with a cheapening of the price this market would be enormously extended. The cultivation of the industrial field is the more desirable in that it would lead us to two goals. It would bestow an incalculable blessing upon the community by reducing the smoke evil, and it would assist our industries by cheapening the cost of production or improving the manufacturing processes. With so much in its favour, the use of gas in industry should become ever more popular, provided the price is right, when all the savings which the use of gas renders possible have been taken into account.

PERSONAL.

Mr. Reginald Harry Skinner, Gas Superintendent to the Glastonbury Corporation, and formerly Assistant Manager to the Gas and Water Department of the Barnoldswick Urban District Council, was married recently at Barnoldswick to Miss Jennie Askham, of that town.

OBITUARY.

It is with regret that we have to record the death on Oct. 2, at a nursing home, of Mr. H. D. Burn, the Managing Director of Metropolitan Gas Meters, Ltd.

FORTHCOMING ENGAGEMENTS.

Oct. 10.—Midland Junior Gas Association.—Opening Meeting.

Oct. 11.—Society of Chemical Industry, Chemical Engineering Group.—Meeting in the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1, at 8.30 p.m. Paper on "Rationalization" by Mr. Davidson Pratt.

Oct. 12.—Manchester and District Junior Gas Association.—Annual General Meeting.

Oct. 17.—Society of British Gas Industries.—Meeting of Council in the afternoon.

Oct. 24-25.—Institute of Fuel.—Annual conference at the Institution of Mechanical Engineers.

Oct. 28-30.—British Commercial Gas Association.—Annual Conference at Eastbourne.

Nov. 7.—Midland Association of Gas Engineers and Managers.—Autumn meeting.

Nov. 13-14.—Institution of Gas Engineers.—General meeting in London.

Nov. 20.—Society of British Gas Industries.—Autumn General Meeting, Hotel Metropole.

Nov. 22.—Southern Association of Gas Engineers and Managers.—General meeting at the Hotel Cecil, Strand, W.C., 2.15 p.m.

GAS STOCK AND SHARE MARKET.

[For Stock and Share List, see later page.]

Stock markets continued in an unsettled state last week, and the only cheerful incident was the success, doubtless due to the tendency of investors to concentrate on "Safety First" securities, of the £6,000,000 preference share issue of the British American Tobacco Company which was more than three times over-subscribed. There were signs, however, that the higher Bank Rate is becoming effective, and quite a strong tone was in evidence in all the principal Government stocks.

Foreign Bonds were a contrast in their persistent dullness; and the Industrial section closed the week in a very sorry state. American operations were mostly of an unfavourable character, and a pronounced fall occurred in the international favourites.

In the Gas Market prices continued to fall. Wandsworth and Wimbledon Company's stocks were again marked down, and the "B" 3½ p.ct. and Epsom 5 p.ct. are now quoted 10 points lower than a month ago, while the three other ordinary stocks show falls of from 5 to 8 points. Imperial Continental capital stock dropped another 5 points on the week, but there was a slight advance in the Primitiva ordinary shares. Further improvement of these shares is predicted; in fact, one financial writer forecasts they will double in price within a few years. In any event, there is no doubt that the shares should be held. The various debenture stocks are attractive at the present time, and trustees not restricted to full trustee investments would be well advised to consider the possibilities of the Gas Light and Coke 3 p.ct. debenture now quoted at 55-58.

The following transactions were recorded during the week:

Monday.—Alliance and Dublin 94¼, Gas Light and Coke 17s. 6⅜d., 17s. 7⅛d., 17s. 10¼d., 18s., 4 p.ct. pref. 71½, 5 p.ct. deb. 98, Imperial Continental 390, 392, 395, 396, South Metropolitan 99½, 99¾, 100½. Supplementary prices, Aldershot 7 p.ct. bonds 100, Brighton and Hove 7 p.ct. deb. 100, Hartlepool 5 p.ct. 82½.

Tuesday.—Alliance and Dublin 94½, 95⅜, British 115¼, 116, Gas Light and Coke 17s. 6d., 17s. 7½d., 17s. 9d., 17s. 10½d., 3½ p.ct. max. 62, 4 p.ct. pref. 71, 72¼, 3 p.ct. deb. 55⅝, 56⅜, 56½, 56¾, 5 p.ct. deb. 98½, Imperial Continental 385, 386, 387, 388, 389, 390, Liverpool 7 p.ct. pref. 100, Wandsworth, Wimbledon 5 p.ct. stock, 107. Supplementary prices, Associated Gas and Electric "A" $68, 70, East Surrey 5½ p.ct. pref. "A" 92¾.

Wednesday.—Bournemouth "B" 12½, 12⅝, British 4 p.ct. deb. 72¾, Colonial 8 p.ct. pref. 22s. 1½d., Croydon sliding-scale 105½, European 15, 15½, Gas Light and Coke 17s. 6¾d., 17s. 7½d., 17s. 9d., 17s. 10½d., 17s. 11½d., 18s., 4 p.ct. pref. 71, 3 p.ct. deb. 56, 56¼, 56½, 56¾, 57, Imperial Continental 386, 391, 392, 393, Primitiva 31s. 9d., 31s. 10½d., 32s., San Paulo 6 p.ct. pref. 8⅝, 8⅝, South Metropolitan 99½, 100, 100½, South Suburban 5 p.ct. 103, Wandsworth, Wimbledon 5 p.ct. stock, 109.

Thursday.—Bristol 5 p.ct. 89½, Colonial 25s. 9d., 26s., Gas Light and Coke 17s. 10½d., 18s., 3½ p.ct. max. 61½, 3 p.ct. deb. 56¾, 57, 5 p.ct. deb. 99, Imperial Continental 388, 390, 391, 393, 394, 395, Metropolitan (of Melbourne) 5½ p.ct. deb. 96, 96½, Primitiva 32s. 6d., 32s. 7½d., South Metropolitan 100½, 6 p.ct. pref. 106½, 107½, Wandsworth, Wimbledon 5 p.ct. stock, 105, 107. Supplementary prices, Croydon 7½ p.ct. pref. 102½, Hornsey 5 p.ct. 104, 105, Northampton 5 p.ct. 75, 75½.

Friday.—Alliance and Dublin 97, British 115¼, 116, 5 p.ct. deb. 96½, European 14⅜, 15, Gas Light and Coke 18s., 18s. 1½d., 18s. 3d., 4 p.ct. pref. 72¼, 3 p.ct. deb. 57½, 58, Imperial Continental 388, 390, 392, 393, 395, Primitiva 32s. 9d., 32s. 10½d., South Metropolitan 100, 100½, 6 p.ct. pref. 106½, 107½, South Suburban 5 p.ct. 103. Supplementary prices, Hornsey 5 p.ct. 105.

The events of last week have again proved that the Bank Rate is a never failing weapon for influencing the exchanges. The exchange rates of all the principal countries have moved in favour of sterling.

Silver was a quiet market, and the price was unaltered at 23½d. per oz., and Gold remained at 84s. 11½d. per oz.

The Bank Rate is 6½ p.ct., to which it was raised from 5½ p.ct. on Sept. 26. The Banks' deposit rate is 4½ p.ct., and the deposit rates of the Discount Houses are 4⅛ p.ct. at call and 4¾ p.ct. at notice.

ON THE ELECTRICAL SIDE.

Shannon Calculations.

Reference was made in an editorial note in last week's issue of the "JOURNAL" to some remarks by Dr. T. A. McLaughlin, Managing Director to the Free State Electricity Supply Board. They were offered when addressing a meeting of the Cork Rotary Club, and were meant to indicate the particular lines on which he expected the Shannon load to develop—domestic consumption, public lighting, and power. He announced that it was the intention of the Board to introduce right through the Free State a rate of 1d. per unit for domestic electricity; and he mentioned a great number of uses to which it might be put—including irons, kettles, vacuum cleaners, toasters, hot plates, floor-polishers, heating pads to replace the time-honoured hot water bottle, refrigerators, hair driers, curling tongs, bell ringing transformers, hot water apparatus, and, of course, fires and cookers. Current is now, it seems, being supplied over a large portion of the Leinster area. In every town or village, the Board regard all premises, except those occupied by the very poor, as being potential consumers; and Dr. McLaughlin stated, taking some typical Leinster towns and villages, that in Abbeyleix 81 p.ct. of possible consumers have signed definite agreements to take electricity, in Baltinglass 70 p.ct., Stradbally 77 p.ct., Tullow 68 p.ct., Rathdrum 67 p.ct., Maryborough 71 p.ct., and Mountmellick 58 p.ct. He went on to express the belief that before the winter is out all these places will approach much closer to 90 p.ct. We must confess that some of these towns and villages are not frequently brought to our notice, and their significance may be much greater than that which we feel inclined at the moment to attach to them. In Limerick and Waterford, where the canvass is thee-quarters complete, 60 p.ct. of the premises canvassed have signed agreements to take a supply. Coming to the Southern Greater Dublin Area, which includes the coastal townships in the districts of Foxrock, Rathfarnham, Kimmage, &c., the canvass is complete, and there have been secured tc date as definite consumers 50 p.ct. of the total houses in this area.

Public Lighting and Power.

Dr. McLaughlin looks forward to the time when every town and village in the Free State will be lighted by means of Shannon current; so that a goodly outlay will be incurred in this respect. Satisfactory public lighting is always a question of cost; and had the authorities been as generous in the past as it is evidently intended they shall be in the future, there would have been less need for the Doctor's remark that "we know how badly and how poorly the towns in the Free State are lit." Then there is the power load, from which much indeed is hoped. From a remark which followed Dr. McLaughlin's address, we gather that the price of current to large users of power has not yet been announced; so there is little to go upon in this connection. It is by no means the only matter upon which further information is needed before the prospects of the scheme can be closely assessed, but it is clearly one of the most important.

The Case of Keswick.

Keeping in mind the promise of current at 1d. per unit for domestic purposes throughout the Irish Free State, let us for a moment consider the case of Keswick, which has been—and, for the matter of that, is still being—much discussed in connection with the proposal to erect overhead transmission lines, and lattice towers, in the beautiful English Lake District. It is pointed out that current is to be supplied from the grid at three farthings per unit, and that the Keswick Electric Light Company are already producing it at a penny farthing, but that so great is the cost of distributing it that the price has to be 8d. per unit at present, although it probably will be 6d. soon. It is argued that if the Keswick Company take current from the grid they will have to spend £20,000 on transformers, relay their cables, and meet all the capital charges of extending the distributing mains to outlying and scattered districts, and charge a price that will pay for that extra capital outlay.

Electric Homes Campaign.

The "E.D.A." Electric Homes Campaign, which is to be carried on through the coming winter, has for its objects: (1) To encourage the demand for, and the provision of, adequate wiring in the homes of Britain. (2) To combat the idea that the installation of electric wiring is expensive. (3) To show that the cost of using electricity for purposes other than lighting is small compared with many other household expenses. (4) To encourage complete domestic electrification. It seems that investigations which have been made show that the majority of houses in this country, and even those being built to-day, are without means for using electricity for purposes other than lighting; and it is felt that the selling and use of electrical domestic appliances is much retarded because suitable plugs are not always available. An essential part of the campaign is to be an "E.D.A." Electric Home Wiring Specification, which is to be designed for the instruction of the public—including architects and builders—and to bring about a larger use of standard material, better wiring, and a greater number of points wired in each house.

GAS COKE FOR ALL HEATING PURPOSES.

The London Coke Committee have published an exceedingly attractive illustrated brochure entitled "Smokeless Gas Coke for Domestic Heating." The manner in which it is written, and the many facts it includes, should certainly promote domestic coke sales. The booklet indicates recent progress in the development of domestic coke-consuming apparatus and domestic coke service in the Committee's area of supply.

It is mentioned that following upon a successful demonstration of a "Metro" open coke fire by the Committee at the new County Hall during the exceptionally severe frost in February last, the London County Council have installed "Metro" coke firegrates in all three main entrance halls of the County Hall. Smokeless gas coke has also been substituted successfully for coal as fuel for the central heating and steam boilers at the County Hall, which consume over 3000 tons a year. A significant result of this change from coal to coke, which should prove of interest to smoke-abatement and fuel-economy enthusiasts, was the automatic lowering of the temperature of the boiler chimney gases from the neighbourhood of 1000° Fahr. to 500° Fahr., indicating the higher radiant efficiency of coke.

Much useful information is given concerning the best methods of realizing the full advantages of coke for water heating; and the illustrations are exceptionally good.

Physical Society and the Optical Society.—The Twentieth Annual Exhibition of electrical, optical, and other physical apparatus is to be held by the Physical Society and the Optical Society on Jan. 7, 8, and 9, 1930, at the Imperial College of Science and Technology, South Kensington. As on previous occasions, there will be a trade section and a research and experimental section, and, in addition, a new section for the work of apprentices and learners is to be introduced. The latter has been instituted with the object of encouraging craftsmanship in the scientific instrument trade.

VALUE OF RUBBER TO THE GAS INDUSTRY.

More and more are the possibilities of rubber in industry being realized, and, thanks to research work on the part of the manufacturers of this versatile material, more and more numerous become its applications. We realize that the gas industry has experimented with rubber for several years, perhaps not altogether with unqualified success; but during recent years the processes of manufacture have advanced to such an extent that what was formerly difficult has now become easy—failure has been transformed into success.

Rubber is a fascinating substance, if only for the reason that its application is so varied. There are now on the market rubber preparations which will withstand acid corrosion and act as an economical substitute for lead. For the lining of saturators used in ammonium sulphate plants, for example, rubber can be put to excellent purpose. Again, rubber belt conveyors are gaining in popularity as a result of the records of their long service under what a few years ago would have been considered impossible conditions. Rubber constitutes an excellent protection for the plates of coke chutes, to mention one other of its many uses. The coke bounces on the rubber instead of acting as an abrasive, and the fact that breakage of the coke is minimized results in a lower production of breeze. Then for packings, for lining bearings where grit is likely to be present, and for many other purposes in a gas-works, rubber can be applied to very great advantage.

In all this work, of course, the adhesion of the rubber to the metal surface is the consideration of paramount importance; and we mention as a matter of interest to our readers that we recently inspected some really excellent work which is carried out by the British Goodrich Rubber Company, Ltd. They have a process of vulcanizing which cannot fail to evoke admiration; and the laboratory resources which this well-known firm have at their command ensure that the correct rubber compound for any particular job is employed. Frankly, we like rubber, and are of opinion that, when its merits are more fully appreciated, it will have very many more useful applications in a gas-works and in the ancillary distribution plant.

USE AND DEVELOPMENT OF GAS IN INDUSTRY.

By S. Tagg, Engineer and Manager to the Preston Gas Company.

[Paper before a Joint Conference, at Buxton, of the Coal Smoke Abatement Society and the Smoke Abatement League of Great Britain.]

The suitability of a fuel for a particular industrial process depends not only upon its heating value, but on other factors, such as readiness of application and ease of control, to which the late Sir George Beilby applied the convenient term of "availability."

Though solid fuels in the form of coal and coke constitute the cheapest source of heat, gas is used in increasing extent in industry, as it possesses in marked degree the advantages of "availability."

Taken in its literal sense, a supply of town gas is available in all industrial areas, whereas transport and storage facilities for coal may only be obtainable at considerable cost. New businesses, along with old, can enjoy the advantage of a supply of gas at little or no first cost, and can rely upon a continuous service night and day throughout the year. Though industrial disputes have been only too frequent during the post-war period, the gas industry, thanks to its mutually satisfactory relations with labour, has avoided internal trouble, and its organization was sufficiently complete to enable it to maintain practically a full supply during the prolonged coal stoppages of 1921 and 1926.

The introduction within recent years of the method of charging for gas on the therm basis, instead of the volume basis, has led to greater uniformity in the composition, specific gravity, and calorific value of town gas. Uniformity in composition and quality ensures an unvarying flame temperature, and permits of the maintenance of oxidizing or reducing conditions at will, and its importance is well illustrated by one of many applications of gas for the heat treatment of metals—viz., the annealing of steel.

Steel which has been mechanically worked by rolling, bending, or forging usually results in a product in which there is internal strain, and this defect is cured and the steel rendered suitable for machining by reheating and cooling slowly through certain critical temperatures. These range from 750° to 890° C., depending upon the percentage of carbon in the steel, and if the limits of variation exceed 20° to 30°, the material under treatment must be scrapped.

Avoid Variations in Temperature.

It is therefore of vital importance to output to avoid variations in temperature, and the use of gas-heated furnaces, with their easy and exact regulation, has proved highly successful in the elimination of waste or rejects.

A further example of the importance of the nature of the heat required in an industrial process is that of rivet heating. Rivets have to be heated up to about 1050° C. before being driven home, and it is essential that they be heated quickly and uniformly throughout. They should further be free from scale, and the furnace should allow of the rivets being put in and taken out without difficulty.

An American shipbuilding firm recently discarded an extensive equipment of coke and oil furnaces, and substituted gas for this purpose, after exhaustive study and exacting tests. Among other reasons they adopted gas firing because it meant rapidity of heating, control of temperature by the operation of a single valve, minimized scaling and rivet wastage, better working conditions, and higher speed resulting from the elimination of smoke, ashes, and excessive heat.

In actual experience it was found that with gas firing the hull riveters put in 300 to 500 more rivets per day; that a ton of burnt rivets was saved per day; and that only one gas-heated rivet was thrown away to every four damaged oil-heated rivets.

In all applications of gas for heating purposes large economies are effected in labour costs and improved conditions provided for those still employed.

Gas in the Motor Industry.

The firm of Morris Motors, Ltd., employ three large gas-heated conveyor stoves for continuous core drying. Each day, the cores required for the 200 cylinder blocks pass through one or the other of two large ovens, which are running almost continuously day and night. They are placed on the conveyor grate at the "feed" end of the oven, and then travel slowly through, the total time of passing being usually two hours twenty minutes, when they become uniformly dried. The staff for loading and unloading the cores, and for supervising the running of the two ovens throughout the complete day, consists of two shifts of seven men. The annual consumption of gas by this firm alone reaches 160,000 therms.

There are many industrial heat requirements which can only be met by the employment of flames, such as the gassing and singeing processes in the textile industry, and in glass making and electric lamp manufacture.

In the former, cotton worsted or silk yarns are drawn rapidly through a small gas flame so quickly that, while the flame chars and removes the loose nap, it does not burn the main thread but gives the yarn a smooth surface. In the singeing process, the fluff or nap is removed from the surface of the woven fabric, which will then bleach and take delicate colours more evenly.

Innumerable other examples of the specialized service which gas is serving in industry could be given, as it is estimated that it is used in over 3000 trades for an average of seven processes in each.

To recapitulate, heat is a universal necessity in manufacture, and coal gas is the most adaptable and efficient means of providing that heat. By its employment waste is eliminated, production cheapened, output speeded up, and the working conditions for the human element improved. In a recent review of the problem, Sir Arthur Duckham summarizes the position as follows:

> There are many processes in industry in which gas immediately commends itself as an ideal fuel. First, where the cost of fuel is a minor consideration, while convenience, cleanliness, labour saving, evenness, and exactitude of temperature are the factors that count.
>
> Take next those industries in which the cost of fuel is a more important item, but on which the exactness of application of the heat is of paramount importance. In this category much headway is being made.
>
> A third class of industries is that in which the cost of fuel is a major item, and the savings to be effected by the use of gas are limited to labour and transport, saving of space for plant and storage, the non-production of smoke, and the recovery of bye-products.
>
> If we roughly divide the industrial users of gas into these three classes, then I estimate it would pay the industries to use gas in case one at a price per therm from ten to twenty times that of raw coal per therm, in case two at a price per therm from five to ten times that of coal, and in case three at a price per therm from three to six times that of coal.

Under present conditions, there is a wide potential market, as yet undeveloped, for gas for industrial purposes, and with a cheapening of the price this market would be enormously extended. The Director of the Research Institute of the Combustion Utilities Corporation of America estimates that the potential market for industrial gas is at present only 2 p.ct. saturated.

Industrial Consumptions.

The consumption in the Birmingham area for heating and motive power is about ten times greater than in the years immediately prior to the war, the annual output in 1928 reaching nearly 3800 million c.ft. The industrial load in Sheffield is about 2400 million c.ft. per annum, and it has been estimated by those best qualified to form an opinion that, with a reduction of price of less than one penny per therm, it would pay the steel works to use gas to an extent which would increase the industrial load fivefold.

It is stated that there are large numbers of furnaces in use fired by raw coal in which the thermal efficiency—*i.e.*, that amount of heat transferred from the coal to the material heated—is little over 5 p.ct., and only those of a continuous type reach at the best under 25 p.ct.

Owing to inadequate facilities for the economic handling of coal, and the large amount of labour required for the coal-fired furnaces, the cost of coal into the fire grate reaches 1·2d. per therm. Gas-heated furnaces will give much greater efficiencies, as the fuel will be burnt with the correct proportion of air and without the heavy loss of heat at present carried away in the form of smoke, and a further economy is possible through the preheating of the air by the waste gases.

Producer gas of low thermal value is used to some extent for gas-fired furnaces in steel works at the present time, but its use is not unattended with difficulties. If hand operated the producers employ a large amount of labour, and in large works more than one plant is required, as it is not practical to convey the gas more than 150 yds. It is also a costly matter to keep the flues or mains free from dust and tar, and the necessity for the temporary cessation of operations seriously hampers production.

Co-operation Between Gas and Coke Oven Industries.

The President of the Board of Trade appointed a Committee this year to consider the closer co-operation of the gas and

coke oven industries, and the terms of reference include the question of a supply of gas on an economic basis to meet the potential requirements of industry.

These industries each carbonize about 16 million tons of coal per year, and the total quantity so treated approximately equals the consumption of coal for domestic purposes in England and Wales, and represents about 20 p.ct. of the total quantity used for all purposes within that area. Those concerned with the question of smoke abatement will be interested to know that the heat requirements of these industries for the carbonization processes are entirely supplied by gas.

In modern gas-works practice, the retorts are heated by producer gas generated from coke, and the sensible heat of the waste gases leaving the retort settings is utilized either for heating the stream of secondary air required for the combustion of the producer gas or for the generation of steam through the medium of waste-heat boilers.

In the most efficient regenerative bye-product coke ovens, about 40 p.ct. of the debenzolized gas produced is required for the purpose of carbonization, and in those of the combination type provision is made for the alternative use of low-grade gas, such as blast furnace or producer gas, thus releasing the richer coke oven gas for other applications. If coal was used for the above purpose instead of gas, over 4 million tons per year would be required, as the internal heat demand of the two industries is five times greater than the heat equivalent of the whole output of electricity by the authorized undertakings in the country.

The coke oven industry is looking for an assured market for its gas at a price which would justify the expenditure required to modernize its plant. The iron industry is looking for oven coke of more uniform quality which such plant, in conjunction with facilities for blending of coal, would produce, and the steel industry is looking for a reduction in the cost of iron and for a supply of gas at a price which would enable further economies to be made.

The revival of the iron and steel industries may therefore be said to depend to a considerable extent on the increased use of gas for industrial purposes, and it is very certain that the only solution of the smoke evil lies in the continued development of the great carbonization industries, including the latest recruit—viz., low-temperature carbonization.

MANCHESTER DISTRICT INSTITUTION OF GAS ENGINEERS.

General Meeting in Manchester.

An Ordinary General Meeting of the Institution was held on Friday, Oct. 4, at the Midland Hotel, Manchester—Mr. W. B. McLusky, the President, occupying the Chair.

After the confirmation of the minutes of the previous meeting, Mr. W. H. Dean (Ellesmere Port) and Mr. W. Buckley (Manchester) were appointed scrutineers of the voting on the election of officers.

New Members.

The next item in the agenda was the induction of the following new members: Messrs. W. S. Sowerbutts, Engineer and Manager, Gas-Works, Stockport; T. V. Blake, Works Superintendent, Bradford Road Gas-Works, Manchester; E. A. Davies, Works Superintendent, Bradford Road Gas-Works, Manchester; B. Hudson, Engineer and Manager, Gas-Works, Pontefract; T. Hornby, Manager, Gas-Works, Hessle; and Mr. N. Hudson, Engineer and Manager, Gas-Works, Mirfield.

The President, on behalf of the members, extended a hearty welcome to the new members.

Examination certificates were then presented. The following obtained the Certificates in Gas Engineering awarded by the Institution of Gas Engineers in co-operation with the Board of Education:

Eric Williams	Higher Grade,	First Class.
Arnold John Leatham	"	"
Bernard Stoneham	"	"
Harry Allerton	"	Second Class.
Ashworth Higham Pinder	"	"
John Pickup Smith	"	"
Arthur Beaumont	"	"
Eric Longbottom	"	"

The following obtained certificates in Gas Supply:

Charles Johnson	Higher Grade,	First Class.
William Fairbank	"	Second Class.
John Edward Lamb	"	"

The President congratulated the successful candidates on the progress they had made in the gas industry; he expressed the hope that they would rise higher still and be well rewarded for their efforts.

Loading and Stresses on Earthworks and Tanks.

Mr. Harold Platt, M.Inst.Struct.E., of Bolton, read a paper, illustrated by lantern slides, entitled "Some Features of the Loading and Stresses on Earthworks and Tanks." This will be found on later pages of our issue to-day.

The President, introducing Mr. Platt to the meeting, said he considered this was a great day for the Institution. That two of the juniors (one a member of the Manchester and District Junior Gas Association, the other a member of the Yorkshire Junior Gas Association) were able to submit such papers as those about to be read was proof of the strength of the Institution; it showed that the Institution was rearing men of good calibre. He hoped that what was to be done on this occasion would be repeated at future meetings. The Institution was rich in members qualified to speak on professional subjects, or to give accounts of their own experiences. There should be no difficulty in securing a paper of high quality every month, but the members had so many engagements that they might not wish this to be done. However, he had been discussing the matter with the Secretary, and he thought that before long arrangements would be made to hold at short intervals meetings in Manchester, and devote the whole of the time to discussing the problems they had at heart.

After Mr. Platt had read his paper, the members adjourned for lunch.

Election of Officers.

When the meeting was resumed, the results of the voting for the election of officers were announced.

President.—Mr. W. J. Smith, B.Sc., of Bolton.

Vice-Presidents.—Mr. W. M. Carr (Stretford) and Mr. C. W. Ward (Wakefield).

Hon. Secretary.—Mr. James Bridge (Elland).

Committee.—Mr. A. L. Jennings (Spenborough); Mr. E. Sutcliffe (Bradford), and Mr. R. Halkett (Sheffield).

Auditors.—Mr. W. Hill (Stalybridge) and Mr. F. Elliott (Leyland).

Mr. Smith thanked the members for the honour bestowed upon him by their choice, and assured them that it would be his delight as well as his duty to do all that he could to make his year of office a time of success for the Institution and of interest to the members.

Mr. Platt's paper was then discussed—see later pages.

"Wet Purification of Coal Gas."

A paper on this subject was read by Mr. Leslie S. Pickles, of Halifax. This, and the discussion which it evoked, will be found in later columns.

Vote of Thanks to the Authors.

Mr. G. Dixon (Lancaster), in proposing a vote of thanks to the authors of the two papers, said that the excellence of the contributions fully justified the experiment of bringing juniors to put their views and experience before the seniors. It promised very well for the gas industry that junior members were able to produce papers of this type.

Mr. R. N. Webb (Leeds) seconded the vote of thanks, and pointed out that one paper dealt with an engineering subject, the other with the chemical side of the industry; both were exceedingly valuable.

Suggested Change of Name.

The President said that Mr. Shapley, the President of the Institution of Gas Engineers, had asked him to bring before the members a suggestion that they should change the name of the Manchester Institution. Personally, he (Mr. McLusky) was a conservative in the matter, and he liked "Manchester District Institution of Gas Engineers." It was a matter of which notice would have to be given. Mr. Sillitoe, of Manchester, wished that attention should be given to the Smoke Abatement Exhibition to be held in Manchester in November, that facilities should be offered to customers in the respective areas to visit the Exhibition, and that steps be taken to organize a campaign. Also he appealed to the gas undertakings to subscribe in support of the exhibition upon the basis of one shilling per million c.ft. of gas made.

Mr. Bridge announced that arrangements were being made by the Institution of Gas Engineers, the Society of the British Gas Industries, the British Commercial Gas Association, and the National Gas Council, for a joint Conference at the British Industries Fair, Castle Bromwich, Birmingham, on Tuesday, Wednesday, and Thursday, Feb. 18, 19, and 20, 1930.

NORTH OF ENGLAND GAS MANAGERS' ASSOCIATION.

Autumn Meeting in Middlesbrough.

The Autumn Meeting of the North of England Gas Managers' Association was held on Friday, Oct. 4, in the Municipal Buildings, Middlesbrough, when a civic welcome was given by the Mayor of the Borough, Alderman George Alexander. The Council Committee Room had been placed by the Middlesbrough Corporation at the disposal of the Association for the holding of the meeting, which was attended by some eighty or ninety members.

The Mayor, in welcoming the delegates to Middlesbrough, said it gave him great pleasure to see them in Middlesbrough not only because of the importance of their visit, but because it was about 35 years, he understood, since a similar meeting had been held in the town. Since that time, and particularly during recent years, gas engineers such as themselves had done notable work to make domestic life easier. They had rendered, and were rendering, a great service to the housewife and family. They had minimized domestic drudgery by adapting and exploiting their product to the full so far as household consumption of gas was concerned, not only in its use as an illuminant but as a means of heating and cooking. The housewife had received many special benefits because of this. As Chief Magistrate of the town of Middlesbrough, he wished to bring before them the great work which Sir Joseph Calvert, Chairman of the Gas Committee of the Middlesbrough Corporation, supported by their present President, Mr. Charles F. Blincoe, Manager of the Middlesbrough undertaking, had done for the town by providing an excellent supply of cheap gas. Their work upon the adaptation of coke oven gas for commercial and public use was something of importance to the gas industry, while at the same time it had meant much to Middlesbrough. Middlesbrough had made big strides in the utilization of coke oven gas. Their inspection of the coke oven plants and works which they were to make in the afternoon would not only reveal to them what the town was doing in the way of gas supply, but must surely be of much benefit to every one of them. They who were responsible for the furtherance of the gas industry in the North would be on the outlook for the methods which would lead to this end.

The President, on behalf of the members of the Association, briefly responded, and thanked the Mayor for his welcome.

Coke Oven Gas in Middlesbrough.

Sir Joseph Calvert then briefly addressed the meeting.

Sir Joseph, as is well known, has been closely associated with the gas industry in Middlesbrough for a considerable number of years, and was largely instrumental in bringing about the utilization of the gas generated in the ovens of local coke and steel manufacturers, for consumption for all purposes in the town. He briefly outlined the work that had been done in this respect from the inception of the scheme.

As gas engineers and managers and officials of big undertakings from large cities in the North, he said, they would probably be fully conversant with the work that had been done at Middlesbrough. The utilization of coke oven gas for the purpose of domestic illumination on a large scale did not in this country at first receive close and thorough attention, and its beginning was accompanied by somewhat slow development. Long before the product was utilized in Great Britain, large cities in America and on the Continent had been illuminated by gas generated in coke oven plants. It was not until about 1903 that efforts were made in Middlesbrough to collaborate with local steel and coke companies. The possibilities of the project were appreciated, and negotiations were opened with a view to putting the idea into operation.

In this connection he wished to recall the work done by those early pioneers of the scheme in the town—Mr. Francis Samuelson, of the firm of Messrs. Samuelson & Co., which was later taken over by Messrs. Dorman, Long, & Co., Ltd.; Col. Hawden; and Mr. Harold Wright. They were convinced that what was then being done on the Continent and in America could be done in Middlesbrough. Much correspondence, he recollected, passed between Messrs. Samuelson and the Corporation with a view to the latter utilizing the waste gases generated in the battery of ovens of the former at Newport, just outside the town. Nothing definite, however, was arrived at, and the scheme was left in abeyance for some years. It was not until 1912 that negotiations were once more opened upon the subject; and on this occasion, a closer relationship existing between the producers of coke oven gas, resulted in the project being carried forward in a more satisfactory manner. The scheme was beneficial not only to the town, but obviously to the local coke producers, many of whom were now included in the undertaking of Messrs. Dorman, Long, & Co.

What had then been a waste product was waste no longer. They received a price for this gas, while the Corporation and the town were saved the necessity of carbonizing large quantities of coal in ordinary retorts. They in Middlesbrough had been the first to introduce this method in this country on a large scale. They were probably still the largest town wholly to employ coke oven gas for all purposes, though there might be larger cities who were taking a greater supply. He concluded by extending to them a very hearty welcome to the town of Middlesbrough.

Vote of Thanks to the Mayor and Corporation.

Mr. W. W. Atley, Engineer and Manager of the Stockton Corporation Gas-Works, proposed a vote of thanks to the Mayor and Corporation of Middlesbrough.

Mr. J. R. Bradshaw, Engineer, Manager, and Secretary of the Hartlepool Gas and Water Company, seconding the proposal, said that he wished to congratulate Middlesbrough in having two such men as Sir Joseph Calvert and Mr. Blincoe to guide the affairs of the gas industry of the town. Their President, he knew, had had his trials and his tribulations, but he had had also his triumphs.

The President said he was anxious to welcome specially two notable visitors to their meeting. They were Mr. C. S. Shapley, of Leeds, President of the Institution of Gas Engineers, and Mr. Charles Wood, late Manager of the Bradford Gas-Works. The members of the Association, Mr. Blincoe remarked, were both gratified and honoured to have with them that day two such distinguished engineers. Though now retired, Mr. Wood was still keenly interested in all matters pertaining to the gas industry. He hoped that Mr. Wood would long be spared to favour the industry with his interest.

Loss by Death.

The Association, the President announced, had suffered a loss by the death of two prominent members, Mr. W. A. Calley, of the Spennymoor Gas-Works, and Mr. J. G. Jewitt, of Sunderland. Mr. Calley joined the Association in 1909, and was a member of the Committee in 1923 and 1925. As a mark of respect and the high esteem in which the late two members were held, he asked the assembly to rise.

Before commencing his address, Mr. Blincoe said that he had a pleasant duty to perform. He had been asked to present Higher Grade Certificates in Gas Engineering to three students of the Institution of Gas Engineers. They were Mr. A. S. Brush, of Amble; Mr. K. Snowdon, of Hexham; and Mr. J. G. Pope, of Workington.

In presenting the certificates, the President tendered his congratulations on behalf of the Association, and added that the future would require all the skill and knowledge which the young men engaged in the gas industry could bring to bear. He had, however, no fear in this respect.

Presidential Address.

The President, rising to give his address, which will be found on later pages of our issue to-day, alluded to the portrait in oils, hung upon one of the walls of the Council Chamber, of Sir Samuel Sadler, whose work upon the Aldermanic Bench had won such high esteem from all, and who was one time President of their Association.

Vote of Thanks to the President.

A vote of thanks to the President for his excellent address was proposed by Mr. A. E. Ruffhead, of Darlington. They had, he said, listened to a most interesting address. It was not only authoritative, but contained new facts about coke oven gas. If the address lacked anything, it was the absence of the characteristic humour of Mr. Blincoe.

Seconding the vote of thanks, Mr. T. M. Waller declared that the address must certainly be of great benefit to all those likely to be themselves associated with coke oven plant.

Mr. C. S. Shapley took the opportunity of supporting the vote of thanks. He said that he thoroughly appreciated the address. It had given him great pleasure to listen to Mr. Blincoe, and he wished to record this not as President of the Institution of Gas Engineers, but as one of themselves.

The President, responding, said that their kind reception of his paper had fully repaid his work upon it. He would take this opportunity, however, to add that what they had succeeded in doing at Middlesbrough was due to no small extent to the way in which his staff had assisted him. Whenever big difficulties lay in their path, every member of his staff had co-operated to remove it; and thus they had succeeded. Sir Joseph Calvert had nurtured the undertaking. Whenever support and encouragement was needed, Sir Joseph was there with ready advice and assistance. It had been mentioned that his address lacked a touch of humour. Perhaps he could make amends now. There was, related Mr. Blincoe, a lodger in a

certain house in Middlesbrough who was troubled with an inefficient gas burner. The light blinked in and out. In exasperation, he asked his landlady what was the name of the Manager of the Middlesbrough Corporation Gas-Works. Somewhat surprised at such an unusual question, she replied, "Blincoe is his name." "Ah!" retorted the dejected lodger, "I thought as much. That's just what the gas has been saying to me for the last twenty minutes."

VISITS TO WORKS.

At the conclusion of the business, motor omnibuses were waiting to convey the members to the gas-works. Here the President himself acted as guide, and an inspection was made of the gas producing plant which Mr. Blincoe had described, and which stands always ready to take the place of the coke ovens if, for any reason, their supply should give out. At present, there reign peace and quietness rarely to be experienced in a gas-works; the exhauster house alone showing any signs of activity. But considerable interest was displayed in the constructional details of a new purifier house which is in course of erection.

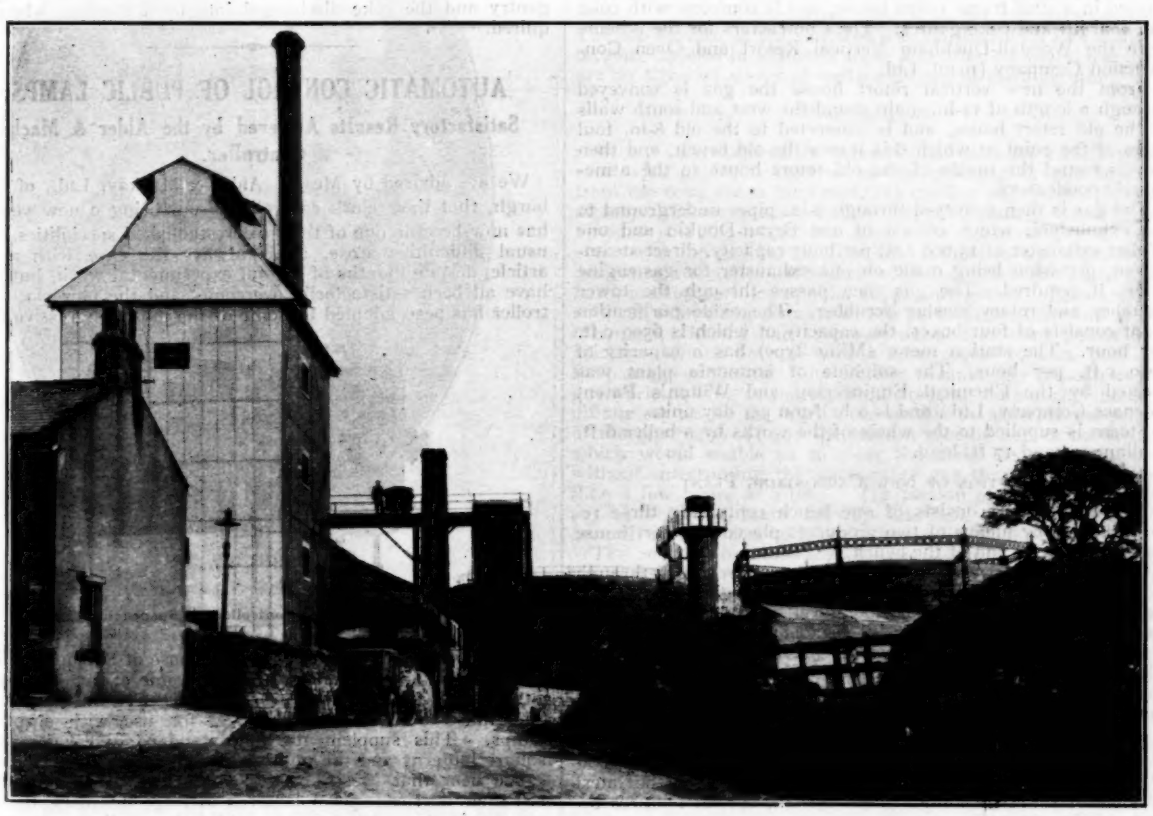
From there, the members were conveyed to the coke ovens of Messrs. Dorman, Long & Co., Ltd., at the Newport Iron Works, which provide the town's gas supply. On the way, the main storage holder was passed—a fine three-million spirally-guided specimen, which stands in splendid isolation at neither the gas-works nor the coke ovens, and which receives gas from the latter after purification at the former.

The members were received at the coke ovens by Mr. Harold Wright, Consulting Chemist to the Dorman Long group, who had at his disposal a corps of guides. The plant consists of one battery of 65 Otto regenerative ovens, and one of 46. The ovens are 34 ft. 6 in. long by 8 ft. 2 in. high, having an average width of 1 ft. 9 in. with a 2 in. taper. Much interest was displayed in the arrangements provided for maintaining a steady and sufficient gas quality for town supply purposes, among the chief of which is a dual main by means of which gas can be drawn in desired proportions from ovens which are at various stages of the carbonizing period. The latter is of 25 hours, for charges of approximately 10 tons, and 900 tons of coal are treated daily. The average proximate analysis of the coal used is ash 9 to 11 p.ct.; volatile 28 to 29 p.ct.; sulphur 0·7 to 1·2 p.ct.; and fixed carbon 58 to 65 p.ct. Weekly outputs are: Coke 4200 tons; tar 200 tons; sulphate of ammonia 60 tons; naphthalene 15 tons; with 15,000 gallons of benzole (65 p.ct. strength). There is 4,500,000 c.ft. of surplus gas per day, of average calorific value 540. Naphthalene is under 2 grains per 100 c.ft., and the nitrogen content averages 6 p.ct. The gas is continually tested by the Beasley recording calorimeter, and checked daily by a Boys calorimeter. In order to maintain gas quality, only some 2½ gallons of benzole are recovered per ton of coal carbonized. The sulphate plant is of the direct process type; two saturators and two Phillipson driers being used. The salt is neutralized by three parts of carbonate of lime to one part of carbonate of ammonia. The salt averages 0·15 p.ct. moisture and 20·75 p.ct. nitrogen.

In the short time left, members were given an opportunity of seeing some of the wonders of modern engineering in the making at the Newport Iron Works, after which they were entertained at tea by Messrs. Dorman, Long & Co., Ltd. Thanks to the famous firm were proposed by the President, and seconded by Mr. F. P. Tarratt, of Newcastle-on-Tyne. An acknowledgment of the vote by Mr. Harold Wright concluded a full and highly interesting meeting.

WOODALL-DUCKHAM VERTICALS AT SILSDEN.

Inauguration Ceremony on Oct. 8.



GENERAL VIEW OF THE WORKS.

In the year 1877, the Silsden Gas Order was obtained, which gave the Local Board power to purchase gas in bulk and to sell gas within their area, but the Order did not enable them to manufacture gas. Prior to this date, gas had been manufactured at Becks Mills by Mr. George Jacques and distributed to a number of consumers, and upon obtaining their Order in 1877, the Local Board purchased Mr. Jacques' mains, &c., for the sum of £628.

An acre of land (the present gas-works site) was purchased in 1877 for £120. An agreement was entered into with the Kildwick Parish Gas Company for a bulk supply of gas, and on Feb. 1, 1878, a supply was first given from this source. In the first complete year the gas supplied through the station meter was 2,734,000 c.ft. In March, 1878, the Local Government Board issued a sanction for the Local Board to borrow the sum of £2000 for the purchase of mains, the laying of new mains, the purchase of land, and legal charges; and in June, 1881, a further £1000 was sanctioned, also for the laying of new mains. These were the only loans authorized prior to the Urban District Council obtaining the Silsden Gas Order, 1902, which authorized the Council to manufacture gas, any exten-

sions of mains carried out in the meantime being defrayed from revenue.

Under the Order of 1902, the Local Government Board sanctioned a loan of £6715 for the erection of new gas-works designed to make 12 million c.ft. of gas per annum, and on April 30, 1904, the gas was turned on from the new works by the late Mr. Tom Fletcher, J.P., who was the Chairman of the Gas Committee.

In the year 1907, a second gasholder was authorized by a sanction for £1650, and the next loan obtained was in 1914, for a new washer-scrubber costing £485. No further loans were obtained until after the war; but, in 1920, the Ministry of Health issued loan sanctions for £1810, £214, £717, £2574, and £629, for water-gas plant, boiler, boiler-house, exhausting plant, and new trunk main, while in the following year (1921) a loan of £629 was authorized for the laying of a gas main to Brunthwaite. The actual cost of this main was £522. In 1923, new tanks were erected under a loan sanction for £525.

We are now brought up to the present time, when, after very careful consideration of the position at the gas-works and the growth of the demand for gas, the Council decided to instal modern vertical retorts, at an estimated cost of £9200.

This work is now completed, and brings the Council's total capital expenditure from loans (including £3000 for mains, &c., prior to making their own gas) to the sum of £30,167.

The present total outstanding debt on the mains and works is £16,100. The consumption in 1905 was 12,430,000 c.ft. To-day it is 36,416,000 c.ft.

Gas Manufacturing Plant.

The old carbonizing plant at the present works, which has been superseded by the new installation of continuous vertical retorts, consisted of four beds of five horizontal retorts and one bed of eight horizontal retorts, 10 ft. long, 21 in. by 15 in., ⊔ shaped. These were charged and drawn by hand. Gas make was supplemented by means of a water gas plant of a nominal capacity of 75,000 c.ft. per day of the "Simplex" type, which was erected in 1920.

The new carbonizing plant consists of an installation of Woodall-Duckham continuous vertical retorts, having a gas-making capacity of 270,000 c.ft. per day. The retort bench is erected in a steel frame retort house, and is complete with coke and coal lift and coke gantry. The Contractors for the scheme were the Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd.

From the new vertical retort house the gas is conveyed through a length of 12-in. main round the west and south walls of the old retort house, and is connected to the old 8-in. foul main at the point at which this leaves the old bench, and then travels round the inside of the old retort house to the atmospheric condensers.

The gas is then conveyed through 8-in. pipes underground to the exhausters, which consist of one Bryan-Donkin and one Waller exhauster of 15,000 c.ft. per hour capacity, direct steam-driven, provision being made on one exhauster for gas-engine drive, if required. The gas then passes through the tower scrubber and rotary washer scrubber. The oxide purification plant consists of four boxes, the capacity of which is 6500 c.ft. per hour. The station meter (Milne type) has a capacity of 5000 c.ft. per hour. The sulphate of ammonia plant was erected by the Chemical Engineering and Wilton's Patent Furnace Company, Ltd., and is a half-ton per day unit.

Steam is supplied to the whole of the works by a boiler 6 ft. in diameter and 17 ft. long.

Description of New Carbonizing Plant.

The installation consists of one bench containing three retorts, heated by means of two producers placed at retort house floor level at one end of the bench.

Coal of a size not exceeding 3½ in. cube is discharged through a chute into a specially designed side-discharging skip. This skip, which travels at cellar floor level, is run into a 25-cwt. steam-engine driven lift. It is elevated to a light steel railway, running along and above the overhead storage hoppers. Thus the coal is discharged into these hoppers, whence it passes through valves into auxiliary supply hoppers attached to the top mouthpiece of the retorts.

The Retort Bench.

The design of the setting is in accordance with the latest practice of the Woodall-Duckham system, special features being as follows:

(1) Each retort is absolutely separate from the next, a straight division wall being built between the retorts, so that any individual retort may be heated up, cooled down, or scurfed without affecting the others. Each retort is provided with its own producer gas, secondary air, and waste-gas dampers, and thus forms a separate heating unit. By thus arranging that each retort is a separate unit, maximum flexibility of output is ensured.

(2) The retort faces and combustion chambers are constructed of the best quality silica material for the full depth of the combustion chambers. This ensures low maintenance costs, coupled with high output per retort.

(3) In order to provide means of varying the relation between the temperatures at the top and bottom of the combustion chambers, means are provided for the introduction of additional secondary air at a second point in the combustion chambers. It is thus possible to vary the zoning of the heats according to the type of coal carbonized and the calorific value of the gas to be made.

(4) Both the side walls and the top of the bench are heavily insulated, with the double object of improving the working conditions and saving fuel.

(5) The producers are of special step-grate design. This type is instrumental in reducing clinkering to a minimum, with consequent reduction in labour costs.

Coke Extraction.

The efficiency of the coke extraction device is of the utmost importance, since upon it is the successful working of the retort dependent. The Woodall-Duckham coke extractor ensures a regular and even discharge of coke without causing cutting or shearing. The rate of extraction can be altered at will, by a simple adjustment to the driving bar which operates the extractor wheel. Under the coke extractor a cast-iron hopper is fitted, with a capacity equivalent to two hours' make of coke. The bottoms of these hoppers are closed by water-sealed, gas-tight doors.

Two step-grate producers are supplied, the grate area of each of which is ample for the supply of gas for heating two retorts. They are so arranged that either producer may be shut down independently, and so that the gas from either producer may be supplied to the heating flues of any of the retorts.

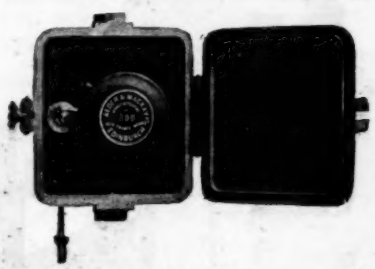
The coke contained in the coke hoppers below the retorts is discharged into a side-tipping skip which runs on rails on the floor beneath the retort bench. For dealing with the coke required for the producers, the skip is run into the lift and is elevated to the producer charging platform level. It is then run along cast-iron plates, which are laid on top of the producer brickwork, to the charging holes of the producers. The coke is thus discharged direct into the producers.

For dealing with the surplus coke, the skip is elevated in the lift to the level of an outside gantry, which has been provided for distributing this surplus coke. The skip is run along the gantry and the coke discharged into open storage, where required.

AUTOMATIC CONTROL OF PUBLIC LAMPS.

Satisfactory Results Achieved by the Alder & Mackay Controller.

We are advised by Messrs. Alder & Mackay, Ltd., of Edinburgh, that their clock controller, from being a new venture, has now become one of their well-established specialities. The usual difficulties arose, as is always the case with a new article, despite months of careful experimental work, but these have all been satisfactorily overcome, and the new clock controller has been adopted by some of the most progressive lighting engineers in the country, such as those of Sheffield, Belfast, Blackpool, and others superintending some of our best lighted cities, and good reports are being received from all quarters. The illustration shows the model for use with suspension lamps. This supplements their standard model for use in square lanterns and the multiple design for reduction lighting.



"A. & M." Clockwork Controller for Suspension Lamps.

We hear that Messrs. Alder & Mackay, Ltd., continue to sell their hurricane-proof lanterns in large numbers, the most popular in the range being the "Edinburgh," a 15-in. square all-copper lamp of pleasing symmetry, suitable for installation in average city streets.

Transactions of the Australian Gas Institute.—The growing strength of the Australian Gas Institute is well demonstrated by the "Transactions for 1928," a copy of which excellently printed publication we have just received. The "Journal" has already recorded the proceedings of the third annual convention which was held in Melbourne on Nov. 20, 21, and 22, 1928, under the Presidency of Mr. R. G. Parsons. The President this year is Mr. H. Tindale, of the Australian Gas Light Company.

PRESIDENTIAL ADDRESS OF MR. C. F. BLINCOE.

North of England Gas Managers' Association, Oct. 4.

My first duty is to offer my sincere and grateful thanks to you for electing me as your President. Conscious of my limitations, it was with some diffidence that I accepted the honour; but with the assistance of the Committee and Members I am hopeful that I shall carry out the duties in a manner befitting the office and worthy of the high traditions of your Association.

Coke Oven Gas for Town Supply.

As the undertaking with which I have the honour to be associated was the pioneer in this country in utilizing coke oven gas for town purposes, and is still the largest undertaking whose whole output consists solely of coke oven gas, I submit it is meet that my address should be largely taken up with matters affecting this system of gas supply.

In common with most ventures of a revolutionary character, the introduction of coke oven gas brought with it certain problems; and I purpose in the first place to describe these, and also the means taken to solve them.

Purification.

Our first problem arose in connection with the purification process. The dry purifying plant consisted of four boxes each 40 ft. square by 6 ft. deep, and two catch boxes each 32 ft. by

THE PRESIDENT

Charles F. Blincoe.

Mr. Blincoe entered the gas industry in 1897 as Chemist under the late Mr. David Terrace at the Corporation Gas-Works, Middlesbrough, after being engaged for eight years as Analyst in the Iron, Steel, and Chemical Works of Messrs. Bell Brothers, of Middlesbrough. He was appointed Assistant in 1911, and Manager in 1916, on the retirement of Mr. Terrace.

16 ft.; the whole being charged with bog ore in two tiers each about 1 ft. 9 in. thick. After its journey of two miles, the gas arrives at the gas-works stripped of tar and ammonia, and at ground temperature; and, in the winter time, this temperature is far too low for purifying purposes. Such a condition had been anticipated, and a range of 3-in. diameter cast-iron pipes had been laid on the floor of each box. The outlet of each range was closed with a steam trap and supplied with steam at about 10 lbs. per sq. in. pressure. By this means the temperature of the gas entering the first box was raised about 20° Fahr. Last year this arrangement was displaced by a specially designed heater inserted in the inlet main, and this has proved more effective; the temperature rise in mid-winter being from 28° to 78° Fahr. at the first box, and falling to 71° Fahr. at the last box.

Early in our experience we found that the oxide in the boxes soon became acid. As the ammonia had been completely removed from the gas at the coke ovens, the usual device for rectifying the acid state was not available; so a small quantity of slaked lime was mixed with the oxide when charging the boxes. This had the desired effect of neutralizing the acidity, but caused a stiffening of the oxide which set up back-pressure. Later on, we discovered that soda ash was a much more satisfactory material. About 4 cwt. of soda ash is spread evenly on the top layer of oxide in each box after re-charging, and evidently this is dissolved by the moisture thrown down by the gas; and the strong alkaline solution so formed percolates throughout the underlying mass of oxide. Last year 2 tons of soda ash were used, and the quantity of gas purified was 1106 million c.ft. The oxide has generally to be passed three times through the boxes to reach a content of 50 p.ct. of sulphur. The purified gas contains about 7 grains of sulphur per 100 c.ft.

Besides neutralizing the acidity of the oxide, the soda ash has been beneficial in the effect it has had on the cyanogen content of the purified gas. As received, the crude gas contains about 25 grains per 100 c.ft. of cyanogen, and after purification this was reduced to about 8 to 10 grains. With the soda ash treatment the purified gas has only a trace of cyanogen, and no doubt the removal of this compound has reduced the corrosive effect of the gas on our storage, distribution, and measuring plant.

About five years after commencing the coke oven gas system, we discovered that very extensive and intensive corrosion had been set up in the cast-iron bottom plates of the purifiers—no doubt due to condensation highly charged with corrosive compounds. The corrosion took the form of deep pitting which perforated the plates in several places. It was decided to cover the bottom plates with a 4-in. layer of fine concrete in which was embedded a steel grill formed of 2-in. angles fixed to the grid support columns and so disposed as to form a key to keep the concrete in position and to strengthen the weakened bottom plates. The accompanying fig. 1 shows the arrangement. The top surface of the concrete was finished with two coats of bitumen applied in a molten state, and after six years' use there are no signs whatever of surface pitting or disintegration.

Naphthalene.

In the early days of the scheme there was no trouble whatever with naphthalene; but as the quantity of gas supplied from the coke ovens increased, the cooling and washing plants attached thereto proved inadequate, and allowed naphthalene to pass into the 20-in. cast-iron main connecting the coke ovens with the gas-works. The first indication was a gradually increasing resistance to the flow of gas, and this continued until it threatened to interrupt the supply altogether. Examination revealed that, for a distance of 800 yards at the inlet end of the main, naphthalene had accumulated, and at some points to a thickness which only allowed a space equal to 8-in. bore for the passage of the gas. The position became very critical, as the gas-works, owing to the rapidly increasing output and the conditions set up by the war, were unable to generate the whole of the gas required; and therefore a scheme had to be devised which would enable us to clear the main of the obstruction without interrupting the passage of gas through it for more than a few hours at a time. The portion of the main affected passed below a main railway line and under open waste ground where access to it could be readily had.

The system is illustrated in the accompanying drawing, fig. 2. At intervals of 125 to 200 ft., openings 20 in. by 8 in. were formed in the main by drilling $\frac{5}{8}$-in. holes at $\frac{7}{8}$-in. centres, and as each hole was drilled it was plugged with a cork to prevent the gas escaping. Immediately the gas was shut off from the main the drilled portions were burst off with wedges, and through the opening thus formed a length of $\frac{3}{4}$-in. service tube was passed to the next opening. To this was attached a $\frac{1}{2}$-in. diameter steel rope, which was drawn back to the first opening. The end of the rope was detached from the tubing, and a drawbar fixed thereto carrying four cutter bars formed of 2 in by $\frac{1}{2}$ in. wrought-iron flats, which were arranged and fixed by locking nut in radial formation after insertion in the main. A trailing rope was attached to the other end of the drawbar, and the whole was pulled to and fro by hand winches between the two openings till the whole mass was broken up. The first set of cutters were 10 in. long, and these were changed after each draw by gradually increasing sizes till a set of 20-in. lengths passed along. These were followed by wrought-iron flats 2 in. by $\frac{1}{2}$ in., again arranged radially on the drawbar, which pulled the broken naphthalene to the opening, where it was scooped out. Finally a 20-in. diameter rubber disc, mounted between two 18-in. diameter wooden discs, was pulled through; and this completed the clearing of the main. By this device a length of 200 ft. could be cleared free from naphthalene in twelve hours. Almost the whole of the deposition was confined to the first 1000 yards of the main from the coke ovens, and altogether over 42 tons were removed in five

clearing operations over a period of six years. The last clearing was effected in 1926. Since then the gas has been washed with gas oil; and as it now only contains 1½ to 2 grains of naphthalene per 100 c.ft., we do not anticipate any further trouble from this source.

It is interesting to note that for two years after the heavy deposition of naphthalene was first observed in the main between the coke ovens and the gas-works, very few obstructions occurred in the town mains or services, though the winters were severe, and the gas sent out to the district contained up to 9 grains per 100 c.ft. Following on this period an attempt was made at the coke oven plant to extract the naphthalene from the gas by scrubbing with benzolized creosote. This improved the conditions in the coke oven main, but brought about great trouble on the distribution system. In the winter of 1923-24, over the months of November, December, and January, 6018 stopped services were reported out of a total of 30,000 in use. To remedy this disturbing state of affairs, it was decided to instal gas-heated paraffin vaporizers on the outlets of the station governors. An immediate improvement was observed, and in the two succeeding winter seasons the stoppages were reduced to 636 and 460 respectively.

Interruptions in Supply.

From the outset we presumed that the regular working of coke ovens would be more subject to interference by labour disturbances in the coal industry or transport services, and by which each man is capable of carrying out. The full staff is built up by engaging outside labour. The character of the local industry—iron and steel manufacture—is of great assistance in this direction, as there is generally ample labour available used to furnaces and readily adaptable to retort-house conditions.

The procedure adopted to meet interruptions in supply of gas from the coke ovens varies according to the circumstances. If the trouble is caused by a breakdown or other circumstance whereby no warning is given, recourse must be had to the carburetted water gas plant to make good the deficiency, because of the rapidity with which it can be brought into operation. For the same reason this plant is brought into operation when the interruption, either partial or complete, is likely to be of comparatively short duration. When the supply from the coke ovens is considerably curtailed or totally suspended, and the trouble is likely to persist over a lengthened period, the coal gas plant is used to make good the deficiency, assisted by the carburetted water gas plant to meet peak loads. If the trouble is due to coal shortage, the two plants are operated so that the mixture produced consists of carburetted water gas and coal gas in the ratio of 4 to 1, or thereabouts. Under these conditions the surplus coke from the retort house is wholly used for the carburetted water gas plant, and the gas produced by the two plants approximates to 50,000 c.ft. per ton of coal treated. As regards the calorific value of the gas so produced, this may be maintained at any desired value by control of the oil used for carburetting.

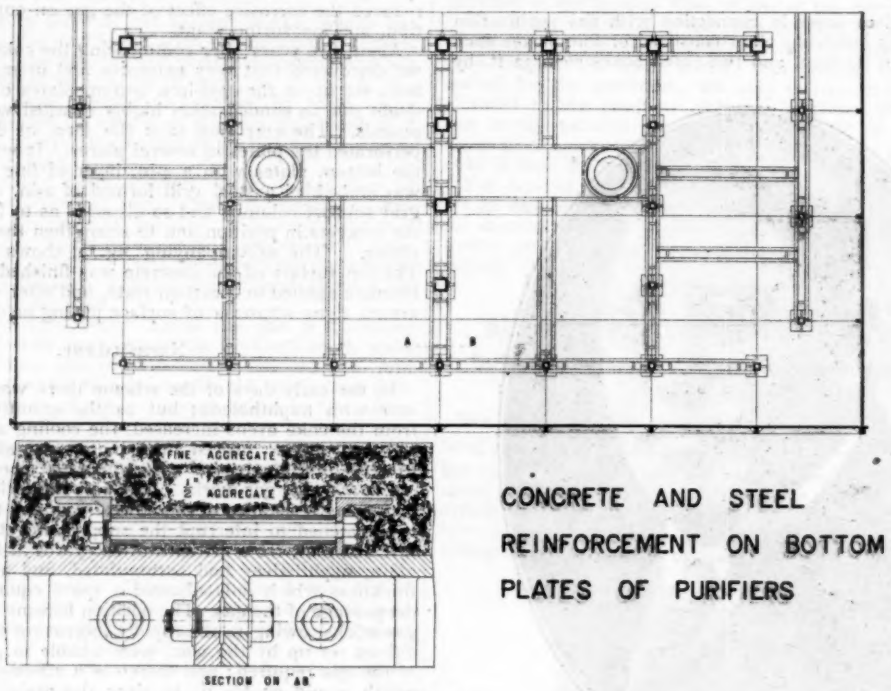


FIG. 1.

trade fluctuations, than a gas-works plant would be. For this reason we decided that a stand-by plant was a necessary concomitant to a coke oven gas supply, and, further, that the stand-by plant must be of a type capable of being brought into full gas-making operation at short notice, and need the minimum of trained labour to operate it. The correctness of these conclusions has been amply demonstrated by our experience since commencing to take coke oven gas.

On three occasions since 1918, the coke oven gas supply has been curtailed, or suspended altogether, owing to labour troubles, and on one occasion owing to reconstruction of part of the coke oven plant. The periods over which the deficiencies occurred varied from two weeks to nine months.

Our present stand-by emergency plant consists of three sets of carburetted water gas plant with a total capacity of 4½ million c.ft. per day, and an inclined retort installation with a capacity of 1¾ million c.ft. daily. These plants are maintained in good condition—all moving parts being turned over at frequent intervals—and the whole kept in readiness for instant service.

It may here be noted that the exhausters, boilers, and purifiers are in continuous use for the coke oven gas system, and are thus readily available for gas-works duty when this is necessary.

Stocks of gas-making materials are maintained at the gas-works, comprising about 4000 tons of coal, 300 tons of coke, and 300 tons of gas oil. The nucleus staff for operating the emergenoy plant is selected from the men normally employed on the works and in the Distribution Department. A register is kept of this nucleus staff, with a note of the particular duty

The principal debit charge due to the adoption and utilization of coke oven gas has been the cost of extending and maintaining stand-by emergency plant. We were favourably situated at the inception of the scheme in that we had two sets of carburetted water gas plant, which, after re-modelling at a comparatively small cost, had a gas-making capacity nearly equal to the maximum day's output to the town.

Over the fifteen years during which the scheme has been in operation, the costs of repairs and maintenance of works have varied from 1·53d. to 6·56d. per 1000 c.ft. of gas sold, with an average of 3·21d. The higher costs, it may be noted, have been incurred for re-conditioning of plant after emergency use for prolonged periods.

It is interesting to compare these figures with the costs over a like period preceding the year 1914. These show that for the fifteen years (1899 to 1914), the average cost was 2·87d. When making the comparison, consideration has to be given to the alteration in values brought about by the war. The greatly increased output of gas—about 100 p.ct. since 1914—has also some bearing on the matter.

When on the question of stand-by plant, it is interesting to note the remarkable degree to which a carburetted water gas plant lends itself to expansion in gas-making capacity at a comparatively low cost. Our original two sets were installed in 1897, and they then had a total generating capacity of 1,200,000 c.ft. of 16 c.p. gas per day. In 1913, after re-modelling at a cost of £1850, their capacity was increased to 1,800,000 c.ft. Again re-modelled, and furnished with the back-run process in 1927, at a cost of £5455, the make was increased to 2,800,000 c.ft.

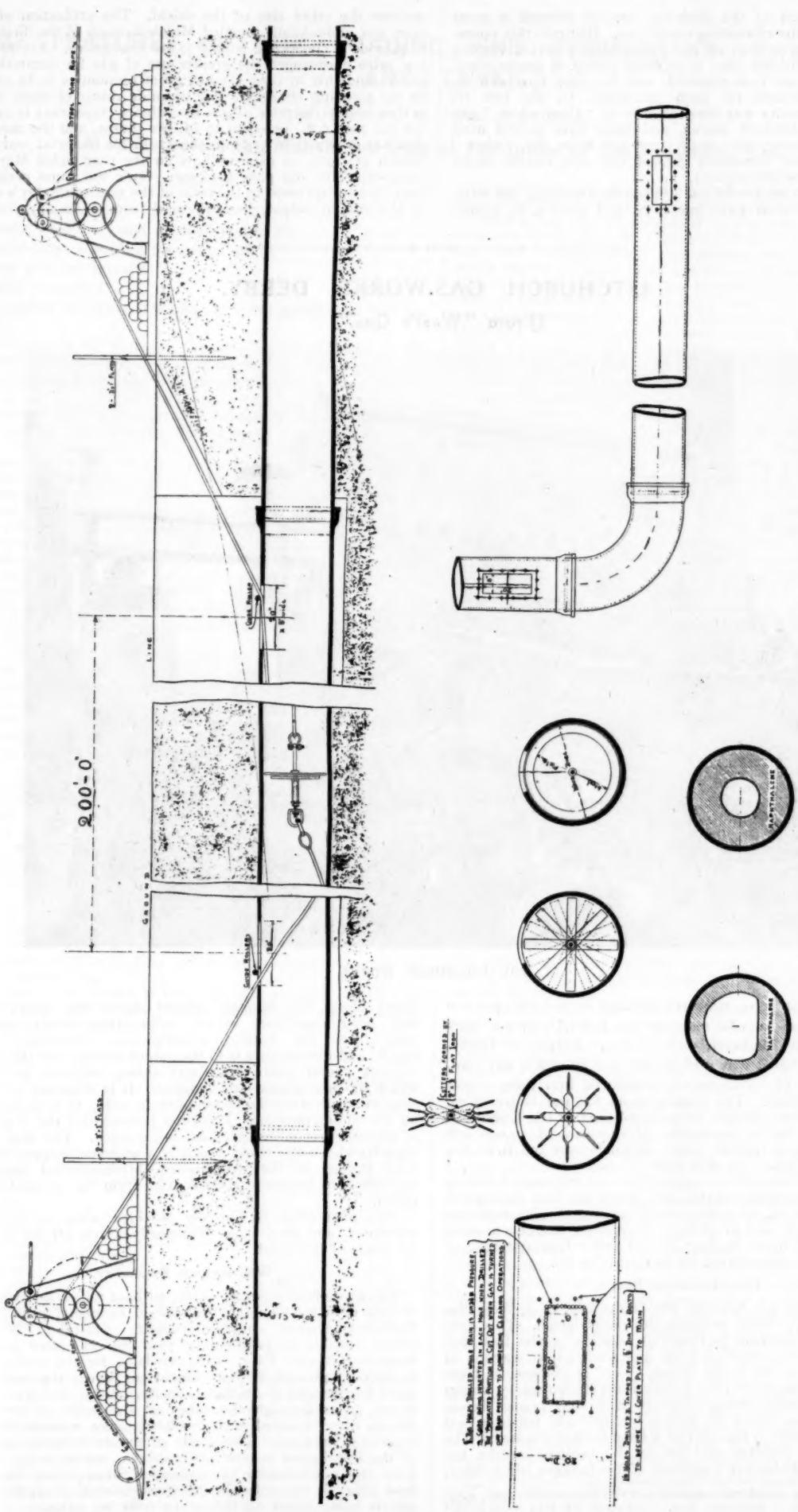


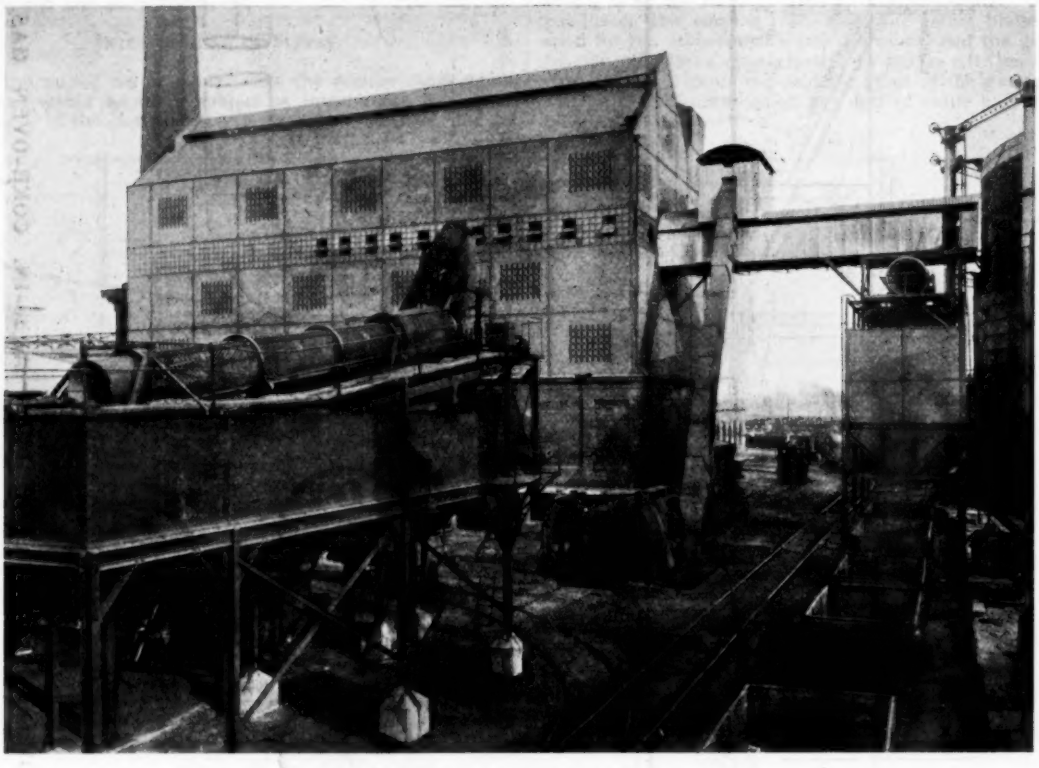
FIG. 2.—METHOD OF REMOVING NAPHTHALENE FROM A 20-IN. COKE-OVEN GAS MAIN.

The introduction of the back-run process effected a great improvement in the clinkering conditions. Hitherto this operation required the services of eight men over a period varying from 30 to 45 minutes after a six-hour period of gas-making. Only four men are now required, and the time has been reduced to 20 minutes for each operation. In the last remodelling opportunity was also taken to fit "Contraflow" grit catchers to the blow-off stacks, and these have proved most effective in arresting the small coke grit from the "blow" gases, which had previously passed out and caused much nuisance to the neighbourhood.

So far, I have dealt with the difficulties attending the introduction of coke oven gas; but I think I should, in equity, disclose the other side of the shield. The utilization of coke oven gas undoubtedly enabled Middlesbrough in the first place to provide a cheapened supply to its consumers. Further, the low price encouraged the greater use of gas for domestic purposes; and this in turn allowed great economies to be effected in the standing charges. The ultimate result of these factors is that to-day the price of gas to ordinary consumers is 1s. 10d. net per 1000 c.ft., or equal to 4d. per therm, and the consumption has grown from 515 million c.ft. in the financial year ended March 31, 1916, to 1042 millions for the year ended March 31, 1929—equal to 102 p.ct. increase. Over the same period the load factor, expressed in the ratio of the maximum day's output to the annual output, has improved from $\frac{1}{2}\frac{1}{4}$ to $\frac{1}{1}\frac{1}{5}$.

LITCHURCH GAS-WORKS, DERBY.

[From "West's Gas."]



THE LITCHURCH WORKS.

As long ago as 1909, we were making 11,500 c.ft. per ton of gas at a gross calorific value of 533 B.Th.U. in our horizontal retorts at Litchurch with 10-hour charges of Derbyshire coal,* so that it was a high standard by which any competitive method of carbonization introduced into these works would be measured. The claims made for the Glover-West vertical retorts had already been established at the Cavendish Street Works, but a production of upwards of 14,000 c.ft per ton of gas at a calorific value, as made over 500 B.Th.U., is an excellent result for this class of coal.

The new installation is erected in No. 1 retort house, formerly occupied by horizontal retorts, and comprises four settings of retorts of the 40-in. steaming model, arranged with eight retorts in a setting and in units of four, with the bench steelwork and retort-house roofing for a further four settings, so that there is accommodation for 64 retorts in all.

THE HANDLING PLANT.

Coal and coke are handled simultaneously by a West lip-bucket conveyor, which encircles the retort bench. This very convenient arrangement is rendered possible by the fact that both materials are received from and loaded into wagons at the same end of the retort house. Coal is discharged from the wagons by means of a West electrically-driven rotary wagon tippler, the contents being received in a steel hopper below the ground, from which the coal is mechanically fed to a coal breaker and thence to the boot of a fixed-bucket elevator. The broken coal is elevated and fed to the buckets on the top strand of the lip-bucket conveyor. The buckets, thus filled, travel along the bunkers placed above the retort bench, and, after emptying, return below that bench, receiving coke from the bottom mouthpieces, conveying, elevating it, and discharging it to the rotary screen over the storage hoppers placed above a railway siding adjacent to that on which the coal wagons are handled. It is therefore not necessary to suspend coaling operations in order to deal with coke on the same conveyor. Provision is made for the duplication of the conveyor when the plant is extended. The coal storage capacity above the retort bench is a 48-hours' supply, and the coke storage in the steel-framed, brick-panelled hoppers is equivalent to 18-hours' surplus coke from the complete installation.

The installation is liberally provided with platforms and staircases, and there is an electrically-driven lift for access to all levels of the plant.

WASTE-HEAT RECOVERY.

The waste-heat recovery plant, without which no installation of this capacity would be considered complete, consists of a Spencer-Bonecourt induced-draught, fire-tube, horizontal boiler, capable of evaporating 7500 lbs. of water per hour, from and at 212° Fahr., with provision for the connection of a second boiler of similar dimensions when the carbonizing plant is extended to its full capacity. A fan for drawing the waste gases through the tubes of the boiler is electrically driven, direct coupled to a ventilated motor without the intervention of gearing. The whole of the mechanical equipment of the installation is electrically driven, power being provided from the main works power-house. Steam from the waste-heat boiler is connected to the works mains, a supply for the retorts being taken off through a reducing valve.

J. F. B.

* See paper read before the Institution of Gas Engineers in June, 1909: "Carbonizing," by J. Ferguson Bell. "JOURNAL OF GAS LIGHTING," Vol. CVI., pp. 844 *et seq.*

SOME FEATURES OF THE LOADING AND STRESSES ON EARTHWORKS AND TANKS.

By H. Platt, M.I.Struct.E., of Bolton.

[A Paper before the Manchester District Institution of Gas Engineers, Oct. 4.]

SYNOPSIS.

Simple foundations.

Ground conditions and physical properties.

Special cases requiring the use of piling.

Earth pressure theories.

Liquid pressure.

Adaptation of these theories to rectangular and circular tanks.

A description of some of the outstanding features of the earthworks engaged upon at Bolton.

Relationship to general engineering practice.

My paper deals with part of a branch of engineering which has occupied the attention of engineers for many centuries past. To-day we have in all probability more theoretical expressions on the subject than upon any other particular form of engineering, and still without having obtained an empirical expression. The boundaries of the subject are extremely wide; and you will have observed from the title that I propose to make reference to a few only of the many features available, and those most applicable to gas-works requirements. I have avoided dealing with the subject on the purely mathematical basis and have preferred rather the general simple terms and graphical methods by which the subject may be easily expressed; and in so doing I hope the paper may be of utility to the engineer who does not have this particular subject always before him.

With the ever-increasing demand for gas and the changing methods of gas manufacture, the structures on a gas-works are becoming more concentrated in certain aspects, and more massive in others, which means that heavier loads are being transferred to the supporting ground. Consequently the type of foundation to be employed for a new building should depend upon the nature of the ground; and where the structure is to be erected upon an existing works, the type of foundation of the existing buildings should be studied and their stability safeguarded while the new excavation and foundation work proceeds. The object of foundations is to prevent excessive and unequal settlement; and the foundation bed should rest on ground of safe bearing value and be so designed as to counteract any inequality of earth resistance, lateral escape of soil, withdrawal of water, and sliding of the substratum on sloping ground. For the smaller types of structures the top soil is generally of adequate bearing value to allow of the use of the simple foundation or grillage bed; on the other hand, for heavy loads the safe bearing ground may only be reached at a considerable depth, through poor soil, water bearing strata, running sand, or muddy clay.

The bearing capacities of soils will vary to some degree with the site, but the following table gives a fair approximation under average conditions:

Material.	Average Weight per C.Ft. in Lbs.	Angle of Repose. Degs.			Safe Stress in Tons per Sq. Ft.
		Dry.	Moist.	Wet.	
Alluvial earth	100	29	45	20	½–1½
Loamy soils	90	40	..	..	½–1½
Loose sand	90	30	..	..	2½–3
Firm sand	100	35	..	..	3½–4
Deep sand	..	..	..	..	5
Muddy clay	110	15	..	..	½–1
Sandy clay	110	30	..	..	2–4
Sound yellow clay	120	30	45	16	4–6
Solid blue clay	125	30	45	20	5–8
Chalk (according to condition)	..	..	..	..	1–4
Sandy gravel	110	28	..	..	6–7
Compact gravel	90–100	45	(Max)	..	7–9
Soft sandstone rock	..	..	..	..	1½–2
Shale, dry and firm	..	..	..	..	6–7
Rock (in general) sound	..	..	..	..	6–20

In the case of retaining walls and gasholder tanks the excavation work is generally carried out by trenches, with the use of sheet piling for the worst cases; for underground storage tanks, trenches or excavation in bulk may be adopted according to the design of the tank. But for buildings the safe bearing ground may be so placed as to be deeper than it is practically or economically possible to reach by digging; then independent piles are usually driven through the poor soils until sufficient resistance is afforded by friction on the sides of the pile or until the point of the pile rests upon some hard substratum. The piles are grouped under each loading in such a way as may be found necessary, and the whole series tied and braced together at the heads by reinforced concrete.

Sheet piling may be composed of concrete, steel, or timber. Concrete sheet piles are mainly confined to permanent work, and steel is used both for permanent and temporary work, while timber in present-day practice is giving way to steel or concrete except under special conditions and in the smaller types of construction. The types of steel sheet piling available are fairly extensive; they vary from light to heavy sections, of plain and troughed shape, and with semi-rigid or flexible interlocks. Concrete and timber piles are chiefly of rectangular section of varying dimensions according to requirements.

As for the advantages of each type—concrete, steel, or timber piling—it is claimed that concrete piling offers greater resistance to corrosion, but at the same time under some conditions sea water has a detrimental effect upon the concrete, ultimately leaving the steel reinforcement exposed. For steel piling the sectional area for the same requirements is considerably less than it is for concrete or timber; hence the power necessary for driving purposes is less. It is also contended that steel piling properly coated with a special paint does not easily corrode. Timber piling possesses advantages under special conditions, such as for piers and under-water foundations, or in the smaller works of construction, but otherwise it is rapidly losing favour.

The main considerations in making a choice of section of sheet piling are that the piles must effectively resist the driving action without buckling, support the depth of ground, or head of water, and be water tight.

In the adaptation of sheet piling for such constructions as steel storage tanks, which give a uniform loading over the whole site, the piling is driven to the required depth; and the ground enclosed is excavated in bulk, leaving a clear site for the foundation bed and erection of the steel plates. For the use of sheet piling for confining a substratum of running mud or sand, the piling on both sides is driven through the faulty ground, when the earth within can be excavated without any danger of the external material being disturbed. This method lends itself admirably to the construction of the foundations for a new building which is surrounded by existing structures and where a withdrawal of the subsoil would seriously affect the stability of the foundations.

Independent bearing piles may be divided into three classes—timber, pre-cast reinforced concrete, and concrete or reinforced concrete cast *in situ*. As in sheet piling, the timber pile is losing favour except for specially suitable cases. The pre-cast reinforced concrete pile has up to the present mainly held the field against the cast *in situ* pile, but in very recent years rapid strides have been made in the method of boring, in the placing and ramming of the concrete, and in the withdrawal of the boring cylinder, and so perhaps the latter type of pile will assume preference.

In the case of the pre-cast reinforced concrete pile the steel reinforcement passes through the whole length of the pile. The reinforcement is framed and braced, and laid in horizontal moulds; and then the concrete is placed and rammed, and allowed to set before the pile is disturbed. For ordinary portland cement the period of time between casting and driving is about four weeks; but with rapid-hardening cement the pile may be driven without damage to the head in 4 to 5 days. The concrete for this class of pile should be carefully graded and rammed, and a mix comparatively rich in cement is usually employed. Many specialist forms of pre-cast reinforced concrete piles are on the market.

The cast *in situ* pile has been developed to a much larger extent in America than in England, perhaps owing to the heavier types of building requiring greater attention to the foundation work. The "Vibro-System" is one of the most modern methods. A steel tube with shoe is driven into the ground to the required depth; concrete is poured in; and the tube withdrawn by a series of direct upward and cushioned downward blows. The inventor of this system found from experiments that concrete in a long vertical tube, such as a pile tube, would not of itself flow freely from the bottom; and at the same time it was necessary to ensure that the concrete filled the hole without voids, as the tube was withdrawn. The action of the direct upward blow gives an upward acceleration of 130 ft. per second to the tube, the frictional hold between the concrete and sides is overcome, and the concrete is deposited layer by layer as the tube rises. The downward blows are cushioned by means of springs; and the feature of the downward action is that the tube and pillar of concrete virtually act together as a solid ram, and consolidation of the concrete is effected over the whole area below the tube.

Many formulæ are available for determining the bearing capacity of independent piles; but they give widely different

results when applied to a standard case. At the same time, a specialist in pile construction usually has a particular set of formulæ covering the range of piles encountered in practice and which he has proved to be more or less reliable. For the Vibro cast *in situ* pile I have prepared a chart [fig. 1] from

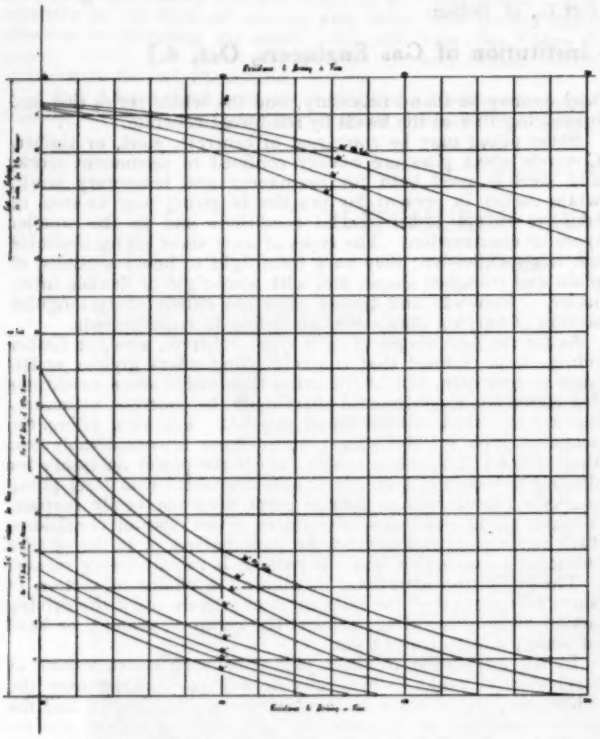


Fig. 1.—Set per Blow of 2-Ton Hammer corresponding to Resistance overcome in driving of Tubes for "Vibro" Piles.

their accepted figures showing the resistance overcome in the driving of different lengths of pile tube in relation to the drop of a standard 2-ton hammer. Three series of graph lines are drawn—first, for a 2 ft. 6 in. drop; secondly, for a 4 ft. 6 in. drop; and thirdly, the drop at refusal. The ultimate resistance of the finished pile, due to later acquired friction between the concrete and earth, which is greater than the friction between the pile tube and earth, is greater than the resistance to driving, varying under ordinary ground conditions from 40 p.ct. increase for a 30-ft. pile to 100 p.ct. for a 60-ft. pile. It is claimed that this increased bearing capacity offers a marked advantage for this class of pile over the pre-cast pile.

In order to ensure against settlement of the pile, a factor of safety between the working load and the ultimate resistance is usually adopted varying from 2 to 4 according to the load.

EARTH PRESSURES.

Approaching the subject from the viewpoint of earth pressures upon vertical walls, I propose, from the many theories available, to make reference to five only, as follows: Coulomb, Poncelet, approximate wedge, Rankine, and Rebhann.

1.—Fig. 2. Coulomb (approx. 1773) assumed a wedge of earth, having the wall as one side and a plane of rupture as

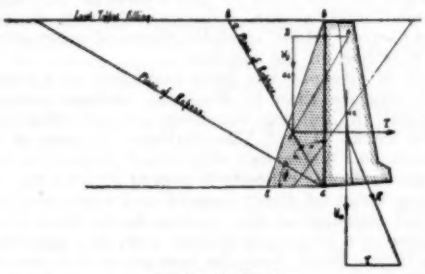


Fig. 2.—Coulomb.

the other side, which exerts a thrust upon the wall. The plane of rupture lies between the back of the wall and the angle of repose of the earth; and he proved that the wedge of earth produced the maximum pressure behind a wall with level topping when the plane of rupture bisected the angle between the plane of repose and the back of the wall. Fig. 2 illustrates this theory, and the wedge of earth, indicated as ABC, forms Coulomb's wedge of maximum thrust. Assuming a condition of no friction between the back of the wall and the earth, and that the particles of earth lack cohesion and are held in equilibrium by friction on each other, we have a diagram of forces as represented by DHF. DF is set down equivalent to the weight of the wedge of earth and acting through its centre of gravity, and DH will represent to scale the horizontal thrust upon the wall due to this wedge of earth. The theoretical position of this thrust lies at a distance of one-third the height of the wall from the base as T. The diagram of pressure behind the wall is represented by the shaded figure BCE. This theory should be applied with caution in the case of a wall supporting a sloping surcharged earth, and the method becomes inadmissible in a case where the angle of surcharge equals the angle of repose.

2.—Poncelet's method (*circa* 1840) is a modification of Coulomb's theory and assumes friction between the back of the wall and the earth. Fig. 3 illustrates this. The diagram of forces according to the Coulomb method is indicated by DHF.

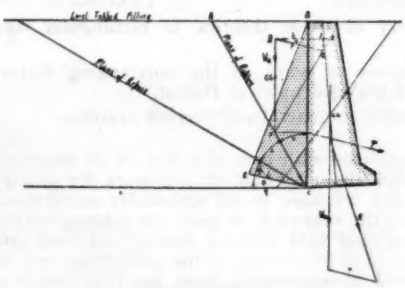


Fig. 3.—Poncelet.

DG represents the inclined thrust T according to the Poncelet method, and DJ is the horizontal component thereof, and the coefficient of friction between the wall and the earth is equivalent to the tangent of the angle GDJ. The maximum thrust according to this method does not always occur for a condition of line of rupture bisecting the angle between the plane of repose and the back of the wall. The diagram of pressure behind the wall is represented by the shaded figure BCE.

3.—The wedge theory is nothing more or less than the Coulomb theory; and in order to allow of its application to surcharged walls a modification is necessary. Fig. 4 illustrates this approximation. The case of a wall with a surcharge parallel to the plane of repose is taken; the wedge of earth,

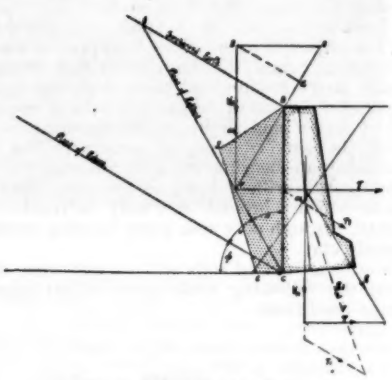


Fig. 4.—Approximate Wedge.

indicated as ABC, forms the wedge of maximum thrust; and the plane of rupture AC is accepted as bisecting the angle between the back of the wall and the plane of repose. The condition of no friction between the wall and the earth is assumed, and we have a diagram of forces as represented by DHF. DF is set down equivalent to the weight of the wedge of earth acting through its centre of gravity and tending to slide down the plane of rupture; and DH will represent the thrust upon the wall acting horizontally from F. A theoretical diagram of pressure behind the wall is shown by the shaded figure BCGJ.

4.—Rankine (*circa* 1856) assumed the earth behind the wall to be of incompressible, homogeneous, granular nature, without cohesion (the particles of earth to be held in position by friction on each other) having a plane top surface, resting upon a homogeneous foundation, and being subjected to its own weight. These assumptions lead to the ellipse of stress, and make the resultant pressure on a vertical wall parallel to the top surface. Rankine makes no reference to friction between the back of the wall and the earth; and although he approached the subject from an entirely different basis from Coulomb, his results are identical for a level topped earth. Rankine applied his theory to a surcharged wall, and stated that the direction of thrust on the back of the wall was always parallel to the surface of the surcharge, though it is obvious that an inclined thrust on the back of a vertical wall due to a vertical load, as from the earth filling, cannot exist unless there is

frictional resistance between the earth filling and the wall face. Fig. 5 illustrates this theory for a level topped earth. Rankine's formula $\frac{W_e h^2}{2} \frac{1 - \sin \phi}{1 + \sin \phi} = T$ represents the thrust acting horizontally at one-third the height of the wall from the base; and the diagram of pressure behind the wall is shown by

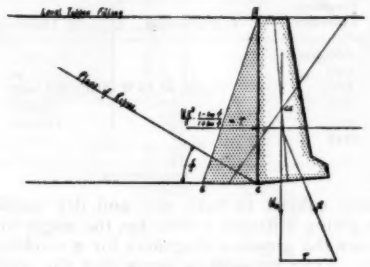


Fig. 5.—Rankine.

the shaded figure BCE. Fig. 6 shows the result of the calculations for a surcharged wall. The resultant thrust T from Rankine's formula $T = \frac{W_e h^2}{2} \cos \phi$ acts at one-third the height of the wall from the base, parallel to the slope of surcharge, and the diagram of pressure behind the wall is shown by the shaded figure BCE. The overturning moment, upon the wall,

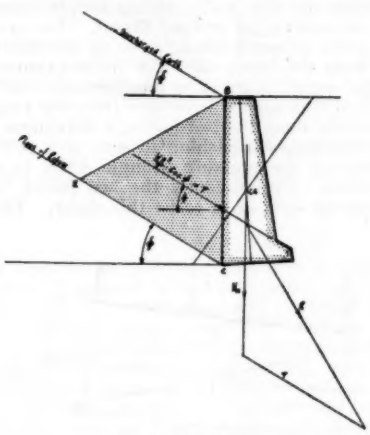


Fig. 6.—Rankine.

of the inclined thrust (fig. 6) is very little greater than that of the horizontal thrust (fig. 5), which is tantamount to saying that a surcharged filling presents only a slight additional pressure behind the wall as against a level topped filling.

5.—The Rebhann and Haseler method has been generally adopted on the Continent, and is applicable to horizontal and surcharged fillings. It is fundamentally Coulomb's theory, and the object of the construction is to determine the position of the plane of rupture. The theory assumes that the first tendency, if movement of earth occurs, is for a wedge of earth as BCL to slide down the incline CL; and the wall is required to resist the pressure due to this wedge of earth, which pressure is calculated from the earth pressure triangle GLJ. Fig. 7

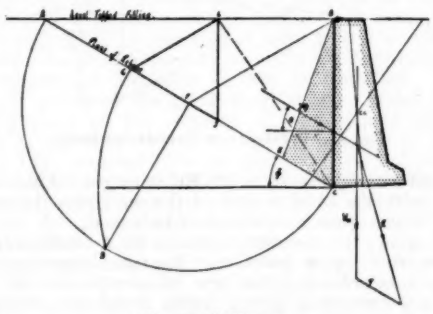


Fig. 7.—Rebhann.

illustrates this method for a horizontal topped wall. The thrust T, per foot run of wall, is equivalent to the weight of a prism of earth as GLJ 1 ft. thick, and its point of application is at one-third the height of the wall from the base. Friction between the back of the wall and the earth is assumed, and the tangent of the angle of inclination of the thrust T to the horizontal is equivalent to the coefficient of this assumed friction. Fig. 8 shows the application of this method for a surcharged earth filling whose angle of surcharge is the same as the angle of repose.

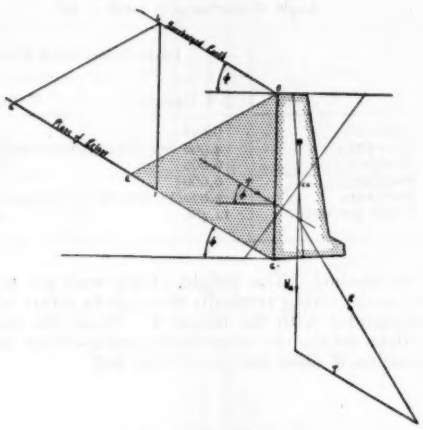


Fig. 8.—Rebhann.

WATER PRESSURE.

The pressure of water or liquid upon the face of a wall can be expressed empirically; and a wall to resist liquid pressure can be designed to a large degree of exactness. Fig. 9 illustrates the method. The total thrust T is calculated from the expression $T = W\ h^2 \div 2$, and the centre of pressure lies at one-third the depth of the liquid from the base. The diagram of pressure is the shaded triangle BCE.

Comparing the values for water pressure with the values for the five methods for earth pressure, I have taken a standard case of a wall with a vertical back to the earth and water. The following table sets down the data assumed and the calculations in accordance therewith.

Again, taking the general expression of either No. 1, 3, or 4 item, the earth pressures for varying angles of repose together

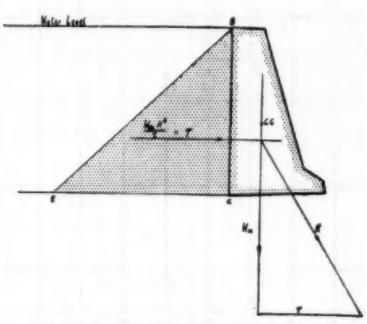


Fig. 9.—Pressure Diagram for Water.

with water pressures for walls up to 40 ft. in height have been set out in the form of a graph illustrated by fig. 10. On the right the horizontal thrusts in total are indicated. No values for friction between the back of the wall and the earth have been taken.

As to the question of this friction between the wall and the earth, it is generally accepted that such friction does exist more or less, but that the values vary considerably, from zero to a maximum coefficient of friction equal to the tangent of the angle of repose. The value that should be assumed depends entirely upon the circumstances, the design and construction of the wall, and upon the ground conditions. For instance, in the case of a brick wall the back is usually very rough and sometimes stepped, and a maximum friction condition is offered; whereas for a concrete wall struck smooth from the sheeting, the friction would be reduced to a minimum. Also a ground subject to vibration will offer a minimum of frictional contact with the back of the wall. Again, the dry, moist, and wet conditions of the ground materially alter the contact between the earth and the wall. In any case the whole data should be carefully noted; and the value for frictional resistance should not exceed that obtainable under the most unfavourable conditions to which the wall or ground may be subject.

DISTRIBUTION OF PRESSURE ON THE FOUNDATION BEDS.

Having determined the magnitude and direction of the resultant thrust upon the back of the wall, we proceed to calculate the effect upon the wall, and to find the relative pressure presented by the base of the foundation upon the ground. For a plain massed wall the procedure is simple. Figs. 2 to 8

Comparative Table of Pressures for Earth and Water for a Standard Case with the Assumed Conditions.

Earth equivalent to 100 lbs. per c.ft.
Water ,, ,, 62·4 ,, ,,
Angle of repose of earth = 30°.
Angle of surcharge of earth = 30°.

Height of wall = 20 ft.
Coefficient of friction between wall and earth = tan 30°.
Pressures indicated in pounds per foot run of the wall.

—	Level Topped Earth Filling.		Height of Centre of Application from Base.	Length of Base C.E. of Pressure Triangle.	Sloping Surcharged Earth Filling.	
	T. Horizontal.	T. Inclined.			T. Horizontal.	T. Inclined.
1. Coulomb . . .	6,666	..	6 ft. 8 in.	666 lbs.	..	..
2. Poncelet . . .	4,998 horizontal component of 5772		,,	684 ,,	..	..
3. Wedge	6,666	..	,,	666 ,,	10,000 at 10 ft. from the base	
4. Rankine . . .	6,666	..	,,	666 ,,	..	17,320
5. Rebhann. . . .	5,070 horizontal component of 5970		,,	686 ,,	..	17,320
6. Water pressure. .	12,480	..	,,	1248 ,,	..	..

illustrate the method. The weight of the wall per foot run is set down to scale, acting vertically through its centre of gravity, and is compounded with the thrust T. From the diagram of forces we thus obtain the magnitude and direction of the resultant thrust as R upon the foundation bed.

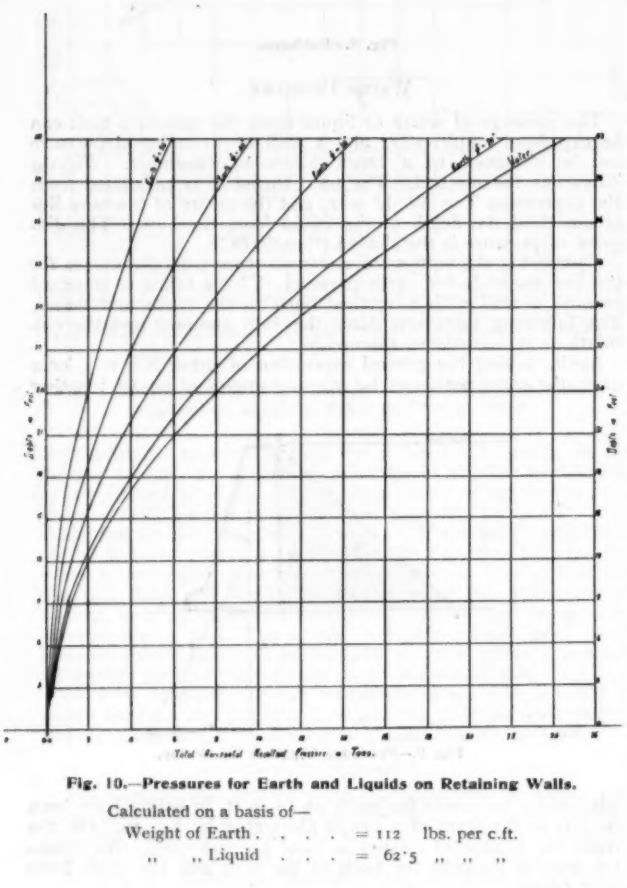


Fig. 10.—Pressures for Earth and Liquids on Retaining Walls.

Calculated on a basis of—
Weight of Earth . . . . = 112 lbs. per c.ft.
,, ,, Liquid . . . . = 62·5 ,, ,, ,,

Fig. 11 sets out pressure diagrams upon the ground for three varying positions of the resultant R in relation to the width of the base. First, for a position when R lies within the middle third. Fig. ABCD represents the pressure, assuming R to be centrally placed; CDFE represents the pressure due to R being out of centre; and consequently ABEF represents the actual pressure diagram.

Second, for a position when R lies at one-third the width of the base from the outer toe, the final pressure diagram is represented by fig. ABC and the pressure at the toe is twice the mean pressure of R over the whole base.

Third, when R lies outside the middle third, the pressure diagram is assumed to be of triangular form with R passing through its centre of gravity as DBC. It is assumed that the inner edge of the wall upon the earth is incapable of offering tensional resistance, and that the tendency is for the wall to open up. Walls supporting liquids should in consequence be so designed as to give a position of R within the middle third; otherwise with open joints the under pressure will affect the stability of the wall and may become of serious nature.

Applying the above theories to the design of such cases where the earth and water pressures are in direct opposition, I propose taking two typical examples—one for rectangular tanks and one for round tanks.

Fig. 12 illustrates a section through a massed brickwork or concrete tank wall; and four conditions of loading are indicated. The data for the basis of the calculations are set down, and a type of ground subject to both wet and dry conditions is assumed, thus giving different values for the angle of repose.

Fig. A shows the pressure diagrams for a condition when the tank is empty. The greatest pressure that the wall is required to resist will then occur under a wet state of earth—that is, for an angle of repose of 34°.

Fig. B shows the pressure diagrams for a condition when the tank is full. The liquid pressure outwards is greater than the earth pressure inwards of fig. A; and a maximum outward pressure will occur under a dry state of earth—that is, for an angle of repose of 40°.

Fig. C shows the effect of tying-in the tank walls with a type of roof formed of cast-iron beam and arched brick, and for a condition of tank empty as fig. A. The beams usually simply rest upon the side walls, adding weight upon them, and are capable of resisting an inward thrust. The centre of pressure of the earth pressure triangle lies at one-third the height of the wall from the base; therefore the maximum thrust the beam is called upon to resist is one-third the earth pressure. The tendency of this outward reaction from the roof is to shear off the brickwork along the bed joints, a maximum shear effect occurring at the top, diminishing to zero at a position as MN where the area of the pressure triangle AMN is equal to the outward reaction. Consequently the bed joints, especially at the top, should be such as to resist this shear. The remaining

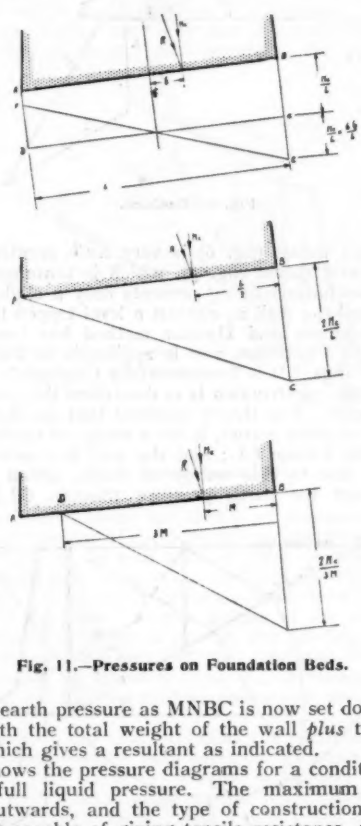


Fig. 11.—Pressures on Foundation Beds.

unbalanced earth pressure as MNBC is now set down and compounded with the total weight of the wall *plus* the weight of the roof, which gives a resultant as indicated.

Fig. D shows the pressure diagrams for a condition of roofed tank and full liquid pressure. The maximum pressure as fig. B is outwards, and the type of construction of cast-iron beam is not capable of giving tensile resistance, which means that the effect of the roof for this condition is merely to add weight to the tank wall.

In each figure the resultant pressure is taken on the bed joint, as BE, and the pressure diagram for each case is set out. Resolving this resultant into its vertical component and compounding it with the weight of the wall below BE *plus* the footing and concrete bed, we arrive at the magnitude and direction of the total pressure upon the foundation bed.

In regard to these four figures A, B, C, and D, I feel that a little explanation is necessary in order that their true relation-

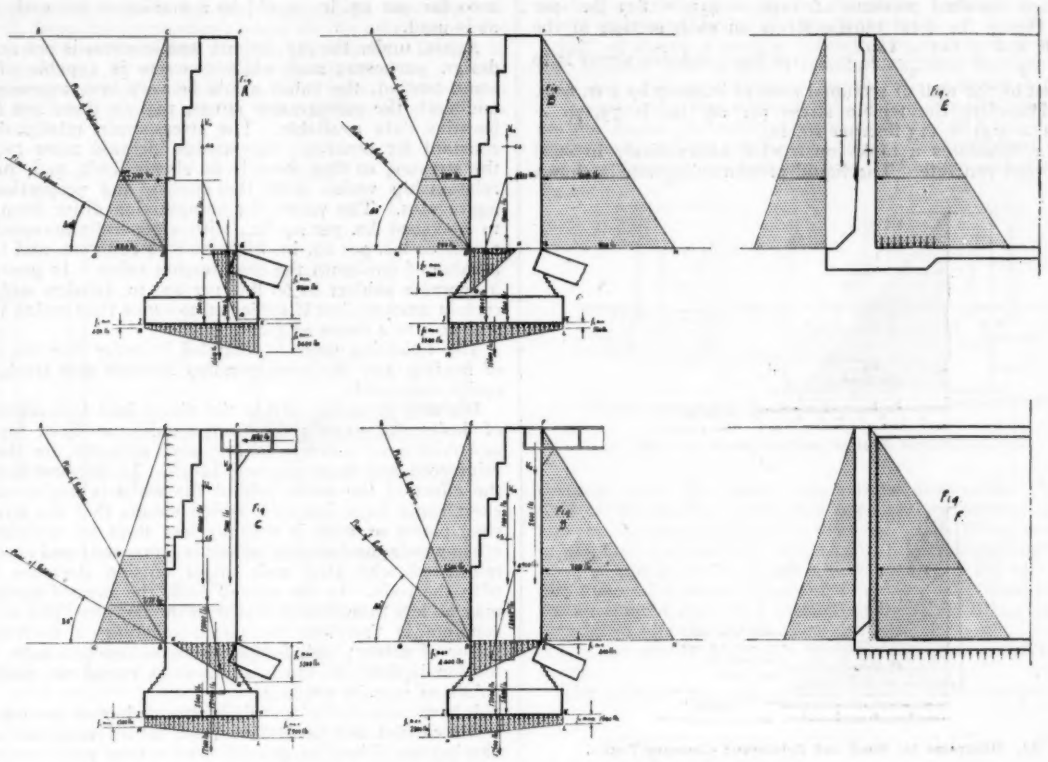


FIG. 12.—PRESSURE DIAGRAMS FOR RECTANGULAR TANKS.

Weight of Earth	= 100 lbs. per c.ft.	Angle of Repose of Earth	= 34° and 40°
,, ,, Liquid	= 62·4 ,, ,, ,,	Width of Base at BE	= 5 ft.
,, ,, Masonry	= 140 ,, ,, ,,	Depth of Tank inside	= 15 ,,

ship to practice may be understood. The type of construction indicated is typical of massed brickwork tanks, and the 5 ft. thickness at the base is greater than will be found in many existing tanks. Considering figs. A and B, we have a maximum compression on the bed joint BE occurring on either edge, according to whether the tank is empty or full, with a corresponding condition of tension or no-tension on the opposite edge dependent upon the capacity of tensional resistance in the bed joints. The fact that the edges of the wall are free from compression leads to the conclusion that the bed joint opens more or less alternatively and may ultimately allow of the incursion of liquid along the joints. In the case of water, perhaps the main effect would be to allow of under-pressure between the bed joint and decrease the stability of the wall; whereas in the case of liquor, in addition to under-pressure, the whole of the bed joint will be liable to attack, and disintegration may occur.

Considering figs. C and D a slight no-tension condition is indicated on the earth side, which could reasonably be accepted, while on the tank side the edge is subject to a compression which should satisfy the requirements.

In all four cases the maximum pressure upon the foundation bed, under ordinary ground conditions, more than complies with the safe requirements, and the whole foundation is shown to be always subject to a compressive stress.

Now comparing the section of the wall adopted for our case as figs. C and D with walls of less thickness, I assume that the main consideration is that such a tank is stable and does not leak, and consequently that certain factors which cannot be accurately determined are more or less in operation. These factors, when acting to the greatest advantage, make a considerable difference to the stability of a wall and may be summed up as follows: On the earth side an angle of repose greater than that assumed to be in existence, the bed joint to be capable of offering tensional assistance, and frictional resistance upon the wall from the earth to be in operation. On the tank side the passive resistance of the earth against the active liquid pressure to have developed.

In fig. 12, alongside figs. A and B and as a comparison, I have indicated an alternative design of reinforced concrete cantilever tank wall, fig. E. The method of treatment is very similar for the earth and liquid pressures and for the pressure upon the foundation bed; but the internal stresses in the wall are now capable of being developed to the full tensile and compressive values.

As a comparison with figs. C and D, fig. F shows the pressure diagrams applied to a reinforced concrete tank whose walls are constructed on the vertical beam and slab principle. The wall may be conceived exactly as a beam and slab floor placed on edge, subject to loadings equivalent to the pressure diagrams and designed accordingly. The foundation bed is subject only to direct dead load due to the weight of the tank itself *plus* the varying weight of liquid stored.

In the case of a round tank, as for a gasholder, and for a condition of tank full, we again have a maximum outward pressure under a state of dry earth. In a round tank, however, the walls are to be conceived as a cylinder subject to internal pressure which tends to burst the sides. The tank walls at

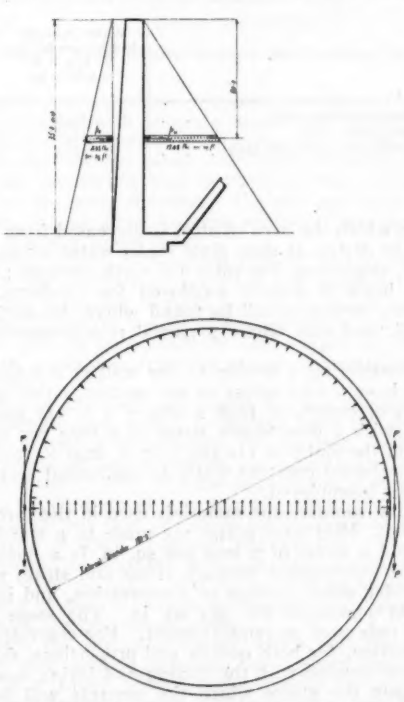


Fig. 13.—Pressure Diagrams for Circular Tanks.

any given depth are under a tensile stress of equal intensity all round, and the stress varies from zero at the top to a maximum at the bottom. Fig. 13 illustrates such a tank based on the data as indicated.

Considering a ring of the wall 1 ft. deep at a mean depth of 20 ft., the pressure diagrams are shown shaded, and we have

a resultant outward pressure of 1248 − 435 = 813 lbs. per sq. ft. Hence the total tensile stress on each section of the wall is $\frac{P \times d}{2} = \frac{813 \times 180}{2}$ = 73,170 lbs.; and this stress is to be resisted by the wall of sectional area 12 in. deep by 4 ft. 6 in. thick. Therefore the tensile stress per sq. in. is 73,170 ÷ (12 × 12 × 4·5) = 113 lbs. per sq. in.

Fig. 14 illustrates a tank constructed alternatively in steel or reinforced concrete. The liquid pressure diagram is shown

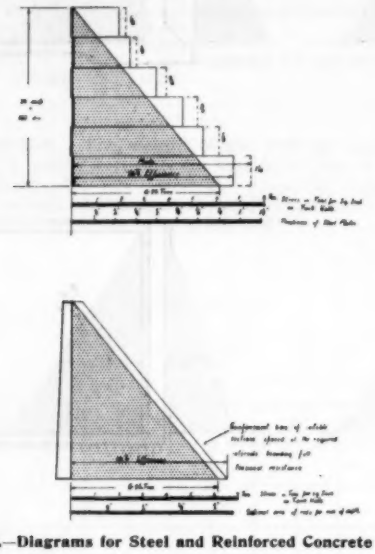


Fig. 14.—Diagrams for Steel and Reinforced Concrete Tanks.

Stress at Base . . . . . = 6·26 tons per sq. in.
Safe Stress, Steel Plates . . = 7 " " " "
" " High Tensile Rods = 12 " " " "

as fig. ABC, over which is transposed the graphical method showing the stress in the steel plates or rods, and indicating the manner in which the area of steel is decreased from bottom to top. In the design of steel plate tanks water pressure only is considered, neglecting the value for earth pressure; and while the same basis is usually employed for reinforced concrete tanks, many instances will be found where the earth pressure is accepted, and also where a partial reinforcement has been adopted.

Again considering a section of the wall at a mean depth of 20 ft., we have a total stress on one section, either steel plates or rod reinforcement, of 1248 × 180 ÷ 2 = 112,320 lbs. For mild steel with a safe tensile stress of 7 tons per sq. in., the thickness of the plates is 112,320 ÷ (7 × 2240 × 12) = 0·6 in.; and for reinforced concrete walls an equivalent sectional area of steel rods is employed.

I will now compare the materials used in the three types of construction. Mild steel plates are made to a standard specification, and a stress of 7 tons per sq. in. is a fairly constant value. The relationship between stress and strain varies very slightly under either tension or compression, and is generally accepted at 30,000,000 lbs. per sq. in. The same applies to mild steel rods used as reinforcement. For concrete, however, the composition, for both quality and proportions, differs enormously, and coupled with the mixing and laying has a definite bearing upon the stress which the concrete will bear. The composition of mass concrete for gasholder tank walls generally varies between a 1 : 2 : 4 and 1 : 2½ : 5 mixture or thereabouts; and the mixing and laying is not usually regarded as of the same importance as for the best reinforced concrete work. The safe compressive stress of a 1 : 2 : 4 concrete with an aggregate of ¾ in. and down, according to the L.C.C. Regulations, should not exceed 600 lbs. per sq. in.; and I can scarcely conceive a practical case where this value would be too low—even under the best of conditions a safe stress of 1000 lbs. per sq. in. would be a maximum for such a concrete as is used.

Again, under the regulations tensile stress is not accepted for design purposes; and while concrete is capable of resisting some tension, the value would be very low, approximating to one-tenth the compressive stress, though there are few corroborative data available. The stress-strain relationship is not constant for concrete; the strains increase more rapidly than the stresses, so that there is no elastic limit, and, further, the relationship varies with the quality and proportions of the aggregates. The values for compression differ from 1,500,000 to 4,000,000 lbs. per sq. in., with a generally accepted figure of 2,000,000 lbs. per sq. in. for a 1 : 2 : 4 concrete, and for tension a value of one-tenth the compression value. In general terms, a concrete subject to 60 lbs. per sq. in. tension will stretch a certain amount, but if subjected to twice the tension the stretch will be 3 to 4 times as great.

The following table is compiled in order that the conditions of loading and the corresponding stresses and strains may be easily compared.

We may therefore divide the above into two different bases of design for exactly the same conditions—first, for the steel and reinforced concrete tanks, and, secondly, for the partially reinforced and mass concrete tanks. In the first case, though the effect of the earth behind the walls is neglected, it must exert some force inwards, which means that the stress in the steel plates or rods is actually less than as calculated, or in other words the factor of safety is increased; and concrete fully reinforced with steel rods under tension stretches uniformly with the rods. In the second case, the inward earth pressure may be less than that accepted in the design. The stress in the concrete is therefore increased, meaning a decrease in the factor of safety; and, further, a mass concrete tank subject to tension is liable to crack at intervals round the walls at such points as may be weakest.

I have prepared a few diagrams and photographs of actual work carried out at Bolton from which may be judged the varying conditions of ground over a very small area, and the methods adopted in the construction of the earthworks; and the slides are shown in order of progress of the work.

In the first place, there is No. 1 well, the first deep excavation work engaged upon in 1924. Preliminary information was gathered respecting the nature of the ground. Two open excavations showed a permanent water level of approximately 16 ft. B.D.; No. 1 retort bench was founded on a good bed at 8 to 10 ft. depth; a railway excavation 9 ft. deep was through dry sand and gravel, the level of the lower yard was approximately 10 ft. B.D.; and the positions of these four items were within a 150-ft. radius of the site. Further, we had in mind that the surrounding district was known to be water-bearing ground, being at one time termed Spa Fields.

Wt. of water = 62·4 lbs. per c.ft.
Wt. of earth = 100 lbs. per c.ft.
Angle of repose = 40°.
Safe tensile stress of steel = 7 tons per sq. in.
Tensile stress in concrete = 100 lbs. per sq. in.
Elastic modulus for steel in tension and compression = 30,000,000 lbs. per sq. in.
Elastic modulus for concrete in compression = 2,000,000 lbs. per sq. in.
Elastic modulus for concrete in tension = 200,000 lbs. per sq. in.

—.	Water Pressure in Lbs. per Sq. Ft. = Ww × h = 62·4 × 20.	Earth Pressure in Lbs. per Sq. Ft. = We × h × $\tan^2 \frac{(90 - \phi)}{2}$ = 100 × 20 × 0·466².	Tension in Wall = P × $\frac{d}{2}$.	Thickness of Wall, Ins. T ÷ ft. × 12.	Increase in Diameter of Tank in Ins. = $\frac{\text{ft.} \times 12 \times d}{E}$.
Mass concrete tank	1248	435	813 × 90 = 73,170	54·5	1·21
Steel plate tank	1248	Neglected	112,320	0·6	1·13
Reinforced concrete tank . . .	1248	"	112,320	0·6	1·13

The original intention was to build a brick tank; but certain causes determined a reinforced concrete type, and the design of vertical beam and slab walls with roof and base slab necessitated the excavation being made in bulk approximately 70 ft. by 50 ft. by 22 ft. deep. The exact nature of the ground as seen upon excavation proved that the inferences made from the preliminary data were not altogether correct. Foundations for two tower scrubbers, a chimney flue, an old 24-in. gas main, and a round 20-ft. well were encountered within the top 10 ft.; and the remaining 12 ft. was to all appearances a good gravel with sand in patches which would stand to a fairly steep angle when the excavation work was completed. But during excavation it was a running mass of mixed material forming a thick slurry at the bottom of the excavation during wet weather. Force of circumstances necessitated the sides of the excavation being left on a slope as shown by the slide; and once these sides had been trimmed, no further land slips were experienced.

Fig. 15 illustrates a section through the foundation for a steel chimney which had to be placed immediately alongside the existing brick chimney. The foundations of the boiler house erected in 1924 were through a firm sand upon a gravelly clay bed; but upon digging for the chimney foundation a patch of running sand was struck in one corner which caused the gravel and clay to become soft. The excavation was timbered with sheet piling and then driven to the shale bed upon which the concrete base was laid.

Fig. 16 shows a section through the No. 2 well. This site

was bounded on one side by the No. 1 well; on the opposite side the old puddled brick tar and liquor tank was approximately 6 ft. from the excavation; while on the other two sides were the machinery house and the old retort house. Owing to the close proximity of the plant on the three sides, careful timbering was deemed essential, and the type indicated was adopted. Evidently it was suitable, since no detrimental effects

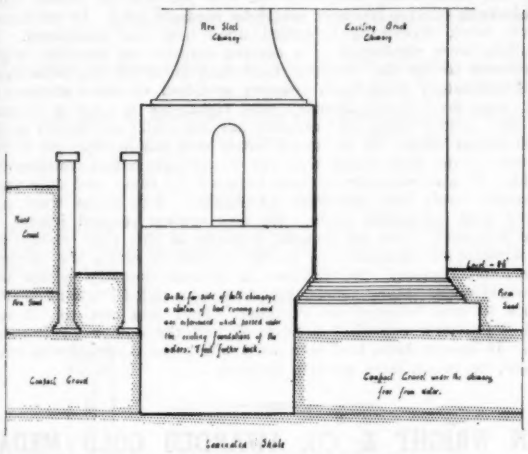


Fig. 15.—Cross Section through Chimney Foundations.

upon the adjoining building have developed. The ground was more difficult to contend with than for the No. 1 well, containing more sand and being more heavily charged with liquor and tar, so much so that on practically the whole of the three sides secondary boards and straw had to be rammed behind the sheeting boards as they were driven down. These sheeting piles could not be driven through the ground in advance owing to

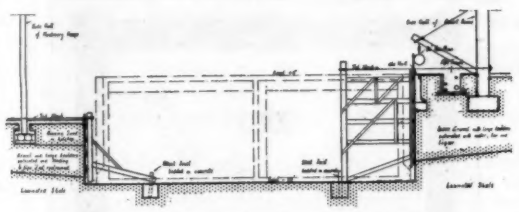


Fig. 16.—Cross Section through No. 2 Well.

the presence of large stones and boulders, and the ground had to be dug from the toe of each board, and the board driven down a matter of 6 to 12 in. and packed behind with straw.

Fig. 17 illustrates the section through the No. 2 well excavation, and shows its relationship to the existing brick tank. The ground between was evidently filled-in material with a large percentage of sand, and in wet weather was like porridge. It will be noticed that live steam, gas, and tar mains were

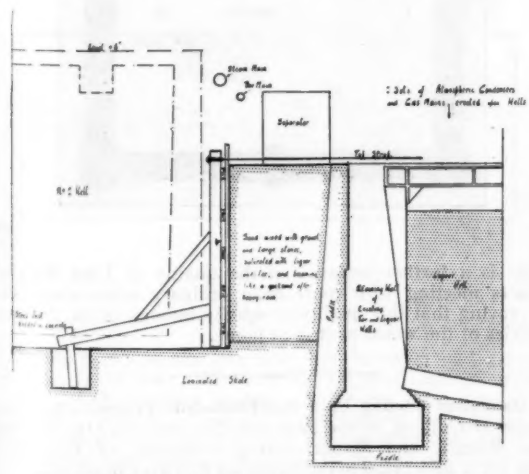


Fig. 17.—Cross Section through Existing and New Wells.

running along the edge of the excavation, and these were successfully slung so as to prevent deflection should the ground sink. A singular feature was unearthed during this excavation. We had encountered a 4-ft. round filled-in well, and at 20 ft. down the sides finished; but the filled-in material continued through the shale bed. At 22 ft. down a workman was trimming up the base slab over the shale when by accident his pick pierced the shale, and a 4-ft. culvert was uncovered, extending 20 ft. in two opposite directions, fortunately just clear of the machinery house and the No. 1 well.

Fig. 18 shows a section through the foundations of the retort houses. No. 1 bench foundations were known to be as indicated; but upon digging for the No. 2 bench a 60 ft. by 12 ft. deep tank was encountered. Upon this site a heavy brick purifier house previously existed, and a small tank under this house was used for storing gas liquor; but the extent of it was not known until the building was dismantled and the top un-

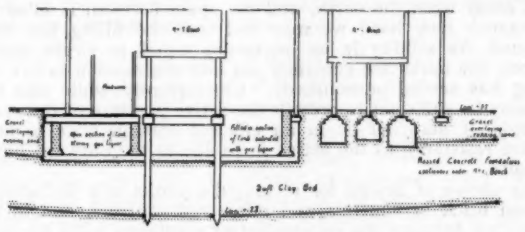


Fig. 18.—Cross Section through Retort Benches.

covered, when the round tank became observable. A division wall of the purifier house had been carried through the tank, and the larger area had been filled in. This filling was flooded in gas liquor to such an extent as to render the filling untouchable, so much so that when it was handled it fell to a porridge and gave off a most objectionable odour. We were practically certain that a shale bed existed about 23 ft. B.D., and it was decided to pile the whole site.

Fig. 19 shows a section through the crusher pit to No. 2 bench.

The ground was of a similar nature to that experienced in

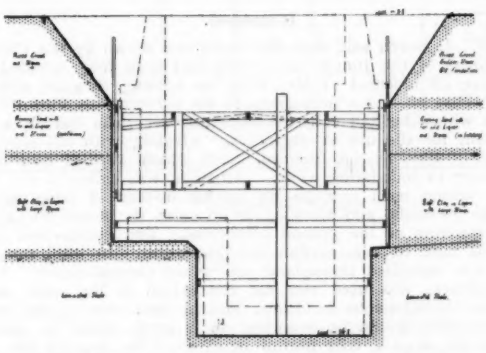


Fig. 19. Cross Section through No. 2 Crusher Pit.

the two wells; and straight compression timbers from side to side were adopted with sheeting boards and straw. The top 8 ft. was sloped in order to reduce the weight on the timbering, to prevent the various other contractors dumping materials close to the excavation, and to facilitate the driving of the timbering at the lower stretches. The clay and shale were very treacherous, falling down in large patches if unsupported, and softening to slurry under water.

I wish now to refer to the adaptation of the theoretical pressures to actual engineering practice; and without committing myself to any particular formula I make these few remarks.

In the first place the weight of any particular excavation will vary from point to point, but the unit weight for design purposes can be ascertained from the average material with reasonable accuracy.

The value of the angle of repose for any material will be found to vary to some extent, depending upon the viewpoint of the person observing the ground, the weather conditions prevailing, and the period of time the particular material has been exposed; and the conditions of the unexcavated ground—that is, the ground which the wall is to support—may be totally different from the conditions that the same material would be exposed to in the open or when excavated and dumped. The value for a design should be accepted only after very careful consideration of the data available, and further should be reconsidered in the event of the excavation work providing information at variance with the preliminary data.

As regards the particular theory which will give results in agreement with general practice, the "approximate wedge" theory, with a further allowance for friction between the earth and wall, or Poncelet's theory, will be found to have preference.

Liquid pressure is shown by the formula $\frac{W_w h^2}{2}$, and the earth pressure theories can all be expressed by the formula $\frac{W_e h^2}{2}$ multiplied by a coefficient; but it is this coefficient which possesses so many variables.

There is one other feature which I should here mention in

relation to the straining of the tank walls. In practically all cases the outward pressure due to liquid is greater than the inward pressure due to the earth, and we should determine the effect of the straining of the walls, especially of circular type, and the amount of passive resistance the earth will offer against same. The diameter of a tank will increase slightly as it is filled, dependent upon the tensile stress within the materials, and the tendency is to squeeze up the surrounding earth. The earth's capacity to resist this compressive force, or its passive resistance, is a very indeterminate factor, and generally may be over-estimated. In most constructions the tank walls are built away from the earth, and the space between is filled in. No matter how hard we may feel that the filling has been rammed, its solidity is by no means equal to virgin earth; further, the tanks are generally put into commission before the filling has settled permanently. Consequently while this filling may be sufficient to present the active pressure of the earth inwards, it may not be in an efficient enough state to offer passive resistance to the active force due to the outward liquid pressure.

The choice of design for rectangular tanks will lie between massed brick or concrete and reinforced concrete, and in the latter case between the counterfort or cantilever walls for open tanks and the vertical beam and slab wall for closed tanks.

In considering the tightness of a tank the question arises as to the advisability of using puddle. The present-day tendency is to omit puddle and rely rather upon some proofing compound or a richer concrete, and of the three I personally prefer the last, with the additional precaution of correct mixing and laying and vigilant supervision. For water storage tanks the use of asphalt forms an excellent preventive against leakage, and for tar and liquor storage tanks a brick lining adds to the safety.

I express my appreciation of the kindness of my Chief, Mr. W. J. Smith, B.Sc., in permitting me to add our experience of the earthworks at Bolton; and in conclusion, although I have put forward these theories tentatively, I hope they will prove not only instructive but useful.

Discussion.

Mr. W. J. SMITH said that the confidence shown by the President in members of the Junior Association had been fully justified, and they were all indebted to Mr. Platt for coming forward with this paper. That he had a firm grasp of his subject was shown by the way in which he had collected data and set them out in a form convenient for the use of engineers. Dealing with his subject in a masterly way, he put forward points which were of considerable importance in foundation work. Attention was called to the necessity of taking each case on its merits, instead of adopting rule-of-thumb methods, and allowing in all cases the same thickness of wall regardless of the ground conditions. The comparison of the materials used in construction was important. In steel tanks the strain was equalized throughout the whole circumference. Where plain concrete was used this did not obtain to the same extent, owing to variations in materials, and in their mixing and laying. This inequality could be overcome to a great extent by steel reinforcement, even if only partial in extent. He thought Mr. Platt was right in pointing out the varying nature of the load to be expected from earth backing. It was certainly better to assume a minimum angle of repose. The paper did not lend itself to criticism, but if any member was not quite clear about any of the points which had been put forward, no doubt they would be explained.

Mr. H. E. STONE (Birkenhead) asked whether Mr. Platt had experienced any difficulty with the cast *in situ* piles. Personally he had not had any trouble. It was mentioned that a special cement could be used in order to get piles set and driven within a short time. He had not found that necessary. At the present moment they had a job on which "Ferrocrete" was used for most of the piles, and they were driven in about a fortnight after being cast. When "Ciment Fondu" was used, they drove piles within three days. He was favourably impressed with that material for such purposes, but, of course, it was rather expensive. Generally, reinforced piles made the cheapest job. The author had spoken about 600 lbs. per sq. in. as the compressive stress of a 1 : 2 : 4 concrete, according to the L.C.C. regulations. It was not quite clear whether Mr. Platt considered this figure should be exceeded; his (the speaker's) opinion was that it would be very unsafe to take a higher figure.

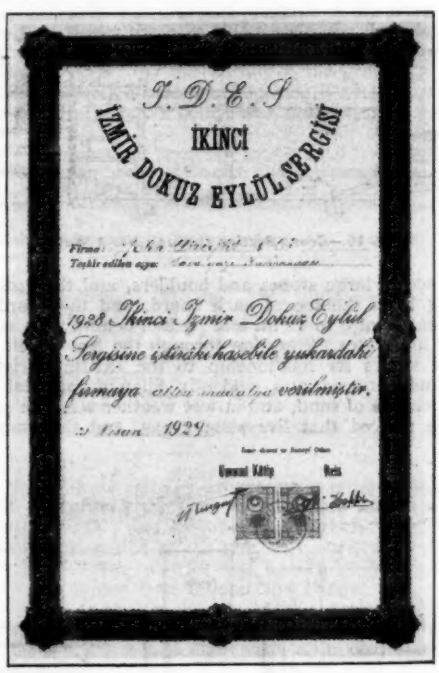
Mr. J. H. CLEGG (Burnley) said that to his mind the paper showed how necessary it was that the Education Scheme of the Institution should take more cognizance of constructional engineering. In recent years there had been a tendency to give too much time to the mechanical side and too little to constructional engineering. Were the walls of the liquor tanks built with vertical or horizontal joints? What was the result when tested for imperviousness to moisture? He himself had had great difficulty in getting perfectly tight joints when constructing tanks for holding liquor or water, whichever method was adopted.

Mr. PLATT, in reply, said Mr. Stone had raised the point whether the pile should be pre-cast or cast *in situ*. The present tendency was to adopt the latter without reinforcement, except for the top 6 ft. or 7 ft. Of course, the length of the pile would depend upon how far the hard substratum was below the surface. The standard length was 30 ft., but a 6-ft. pile could be used comfortably if provision was made against the side-buckling due to the tendency in subsidence running towards the pile. It was all a matter of making the pile sufficiently strong to withstand the conditions. The present-day tendency seemed to be to use a fast-setting cement. "Ferrocrete" was the standard cement now made in England, and the price was only a few shillings above that of the ordinary standard slow-setting cement. In setting properties it was much quicker. Using "Ferrocrete" cast *in situ* piles could be driven in about three days, whereas with ordinary slow-setting cement the same job would require a fortnight. For pile work "Ciment Fondu" had advantages over "Ferrocrete;" it was more rapid and harder in the first few days of setting. Of course, the price of "Ciment Fondu" was about twice that of ordinary slow-setting cement. As regards the compressional stress allowed upon concrete being 600 lbs. per sq. in., this was for a standard 1 : 2 : 4 concrete under the existing L.C.C. regulations. Another set of regulations had been put before the L.C.C. for consideration, and perhaps the stress figure for standard 1 : 2 : 4 concrete would be made higher. In reinforced concrete work everything depended upon how one reinforced. If the pillars were reinforced in a certain manner the 600 lbs. might be increased to 750 lbs. Messrs. Earle had made an enormous number of laboratory tests upon cement, and had obtained stresses of about 1050 lbs., if his memory was right, for a 1 : 2 : 4 mixture of ballast, graded sand, and cement, but one could not expect to get this in actual work. If too much water was put in, one got a bad concrete; if too little water was put in, one got a bad concrete full of voids. It was necessary to keep between the two; and only years of practice could tell one what to obtain. The tanks were constructed with horizontal joints. He was against vertical joints.

The PRESIDENT said he thought a paper of this kind should not pass without an expression of thanks to Joseph Astin, the inventor of Portland cement. He founded a British industry which was now world wide. Many people thought it was called Portland cement because it was invented in Portland. That was not so; it was called "Portland cement" because it had the colour of Portland stone. If Joseph Astin had been born where the material was ready to hand, he might have made a fortune.

JOHN WRIGHT & CO. AWARDED GOLD MEDAL AND DIPLOMA AT THE SMYRNA EXHIBITION.

We reproduce a photograph of the Diploma awarded by the Committee of the Smyrna Exhibition to Messrs. John Wright & Co., for excellence of quality in gas cookers and gas grates. A very fine Gold Medal accompanied the award of the Diploma.



This is a further instance of the quality of John Wright's products meeting with more than ordinary acknowledgment, and proving that this quality is equally famous in the far-away countries of the world as it is at home.

Aluminium Coating by a Non-Electrolytic Process.—According to Leon McCulloch, of the Research Department of the Westinghouse Electric and Manufacturing Company, of East Pittsburgh (in a paper read to the American Electro-Chemical Society) a dead-white coating can be given articles of aluminium by boiling them in "milk of lime" with the addition of a little calcium sulphate. No electric current is needed. The coatings are not so thick, nor are they so hard, as those formed by electrolytic methods, but their dead white colour gives them a better appearance. They may on this account have various uses. They might, on account of their porous structure and their good adherence, make an excellent foundation upon which to apply paints or enamels to aluminium.

"WET" PURIFICATION OF COAL GAS—A REVIEW OF PAST AND PRESENT METHODS.

By L. S. PICKLES, M.Inst.Gas E., of Halifax.

[A Paper before the Manchester District Institution of Gas Engineers, Oct. 4.]

The aim of this paper is to present the position of the gas industry so far as modern practice in "wet" purification is concerned, and to speculate upon probable future developments which may be expected to result from the ever-changing requirements of the times.

HISTORICAL SURVEY.

Developments in the practice of "wet" purification may be divided into three periods—First, 1792-1851; second, 1851-1905; third, 1905-1923.

THE FIRST PERIOD, 1792-1851.

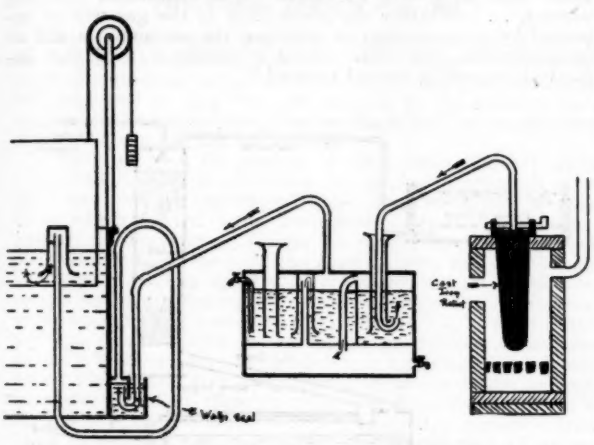


Fig. 1.—Accum, 1808. Early Plant for the Manufacture of Coal Gas.

It will be seen from the figure that the gas was considered ready for use after little or no purification. This state of things did not exist long before it became obvious that a method would have to be found to free the gas from impurities, as apart from the sulphurous fumes produced by the gas when burning, the crude gas quickly reacted with the copper and brass service pipes, often causing a complete stoppage of the supply. In 1808 Winsor used lime-water for the extraction of the sulphuretted hydrogen. The washer he used is shown in fig. 2, and was simply a square box containing a perforated

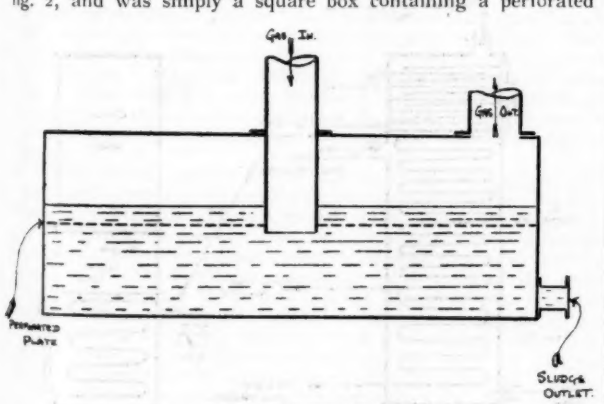


Fig. 2.—Winsor, 1808.

plate, which caused the gas to bubble through the lime-water contained in the box. We have here the first application of the principle of the Livesey washer. About the same time Taylor patented a method of purifying gas (made from bones and animal matter) from sulphuretted hydrogen by lime-water and from ammonia by dilute sulphuric acid, though he did not apply this method to coal gas.

In 1817 we find the record of a patent gas washer by Wilson which shows a knowledge of the use of ammoniacal liquor as an absorbent of sulphur compounds. In his specification he states that the invention relates "to the purification of coal gas from sulphuretted hydrogen by means of ammoniacal gas, which may be achieved by causing a stream of this gas to mix with the coal gas and to pass through a perforated plate placed under the surface of water contained in a suitable vessel before reaching the gasholder." The reactions involved, though not understood at that time, are:

$$NH_4OH + H_2S = NH_4HS + H_2O$$
$$2NH_4OH + H_2S = (NH_4)_2S + 2H_2O$$
$$2NH_4OH + CO_2 = (NH_4)_2CO_3 + H_2O$$
$$NH_4OH + CO_2 = NH_4HCO_3$$

Although Wilson's apparatus was adopted by the London Companies, "the ammoniacal liquor produced proved to be not only unprofitable, but an obnoxious, troublesome drug, which caused the greatest inconvenience in its disposal. In many cases it was allowed to flow into the sewer, river, or sea, according to the position of the works, thus often giving rise to serious complaints and contributing greatly to retard the progress of gas lighting."[1] Clegg, therefore, used milk of lime as the washing medium in place of liquor, and to overcome the slight solubility of the lime added a hand-driven paddle, while Malam placed three of these washers on the top of one another in order that one man could operate three machines.

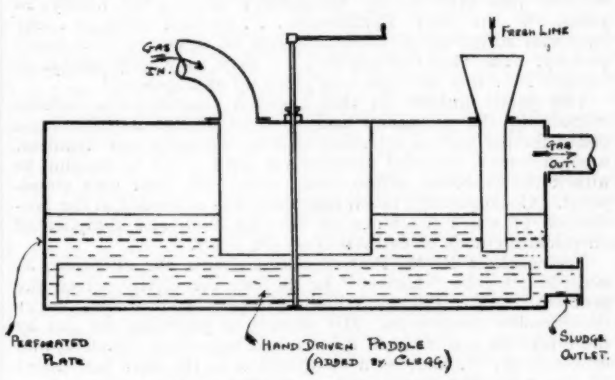


Fig. 3.—Wilson, 1817. Clegg, 1819.

The chief drawbacks attending the above method were the difficulty of disposing of the effluent, "blue billy," and the pressure thrown on the retorts. Bowditch, commenting upon this effluent in 1867, says, "the Sanitary Regulations most properly prevented the running of the 'blue billy' into streams and rivers;" hence the introduction by Phillips in 1817 of his so-called "dry lime purification process" was widely welcomed.

In describing his invention Phillips states that he takes a quantity of well-burnt lime and adds sufficient water, so that the particles of lime just adhere together, ensuring contact with the gas. This prepared lime is then placed upon perforated trays in closed vessels and the gas caused to pass through it. Several trays and vessels were used depending upon the quantity of gas to be purified.

The reactions involved in the use of lime, as understood to-day, are as follows:

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$$
$$Ca(OH)_2 + H_2S = CaS + 2H_2O$$
$$CaS + CO_2 + H_2O = CaCO_3 + H_2S$$

$$Ca(OH)_2 + 2H_2S = Ca(SH)_2 + 2H_2O$$
$$Ca(SH)_2 + H_2O = CaOH.SH + H_2S$$
$$\text{or } 2Ca(SH)_2 + O_2 = 2CaOH.SH + 2S$$

$$2CaOH.SH + CS_2 = H_2S + Ca(OH)_2.CaCS_3$$
$$\text{or } 3CaOH.SH + CS_2 + H_2O = 2H_2S + 2Ca(OH)_2CaCS_3$$

Although this process overcame the effluent problem of that day, the engineers were faced with the problem of disposing of the spent lime sludge. This difficulty led to the introduction of oxide of iron by Hill in 1849. He claimed that the oxide, after use, "might be restored to its original efficiency by exposure to air and could be used over and over again until the material became so 'clogged' with precipitated sulphur that the gas could not effect contact with the oxide; the accumulated sulphur could be then converted into sulphuric acid."[2] This process only removed the H_2S; but in spite of this, it proved a great boon, particularly to the smaller gas companies, who were relieved by it from the difficulty attending the disposal of the foul line.

There were wide differences of opinion as to the advisability

[1] "Peckston on Gas Lighting," 1819.
Re-quoted in the "Gas Journal," 1874, Oct. 6, p. 467.

[2] "Bowditch on Coal Gas," 1867, p. 20.

of using water or/and ammoniacal liquor to free the gas from ammonia owing to the loss of illuminating power produced by the washing process. Also, several of the Metropolitan companies tried sulphuric acid but discontinued its use for the same reason.[3] To this failure in the purification of gas by acids may be partly attributed the care subsequently bestowed upon the utilization of the ammonia products of gas-works, for as large sums were realized from the sulphate of ammonia, obtained by the acid purification, the value of the impurity came to be recognized, and gradually other means were adopted to secure the profit.

This brings us to the close of the first period, during which we find an almost universal output of comparatively foul gas, with gas engineers divided in their ideas as to the best method of purification, increasing difficulty in the disposal of foul lime, and, lastly, a growing interest in sulphate of ammonia as a possible source of revenue. Apart from these difficulties there was dissatisfaction among consumers, caused by the deleterious action of the products of combustion from the gas supplied, upon the brass fittings, furniture, books, &c.; and public opinion in London was finally responsible for "The Central Consumers' Act" of 1851, which imposed a limit of 20 grains per 100 c.ft. of gas supplied, instituted penalties for failure to keep within this limit, and so made imperative the development of an effective method of removing sulphur compounds from the gas.

THE SECOND PERIOD, 1851-1905.

The following extract from a copy of the "Lancet" (1860) sums up the situation: "The foulness of London gas with sulphur has been loudly complained of . . . for nearly 20 years. . . . In 1851 Parliament . . . enacted that . . . any excess of 20 grains of sulphur should be subjected to a heavy penalty. The Gas Companies . . . were so wholly unable to comply . . . that the case was given up as hopeless."

The public interest in this question constituted a definite menace to the prosperity and advance of the industry, and called for the serious attention of both engineers and chemists, who, however, retarded progress for some years by electing to attack the problems before them, each from their own standpoint. Consequently, much ingenuity was expended in the production of weird machines on the one hand and complicated chemical methods of extraction on the other.

The work of R. H. Patterson first claims our attention, as according to the "Lancet" he at once completely solved the problem. "Mr. Patterson has laid the gas consumers under considerable obligations. His process of purifying the gas by the ammonia contained in it is at once ingenious, effective, and economical . . . and, as a contribution to the final settlement of the 'Sulphur Question,' is worthy of the author's . . . painstaking research and lucid exposition." Although Patterson's work hardly takes us so far as this report would indicate, he certainly led the way to the development of an effective system of wet purification.

His method, in brief, was as follows: Two vessels were employed, each charged with ammonia, lime, or caustic hydrate. In the first vessel sulphuretted hydrogen and carbon dioxide were absorbed; but the carbon dioxide, having the greater affinity for the absorbing fluid, gradually expelled the sulphuretted hydrogen. Thus the hydrate in the second vessel quickly became a fairly strong alkaline sulphide with a great affinity for carbon di-sulphide and sulphur dioxide; the sulphuretted hydrogen remaining passed forward to the dry purifiers. It is, however, necessary to have a strong solution of ammonia in the first vessel in order that all the carbon dioxide may be absorbed; and the difficulty of obtaining this solution was the chief cause for the failure of this system.

This brings us to the work of Hill, Livesey, and Holgate, all of which work is on the so-called "decarbonization of liquor"—in other words, attempts to obtain this strong ammoniacal solution by recirculating the liquor and periodically expelling the carbon dioxide. Livesey first tried to desulphurize the liquor by passing it down a coke tower, up which he passed cooled waste gases from the retort stack. This plan, though partially successful, "did not pay;" and in 1869 Hill came into the field with another method for removing both sulphuretted hydrogen and carbon dioxide, by heating the liquor to approximately 190° to 200° Fahr.

Referring to the Hill process in 1875, G. Livesey said: "Were it not for the necessity of reducing the sulphur compounds, the purification from carbon dioxide and sulphur dioxide could be almost entirely accomplished by means of the liquor, charging the ordinary purifiers with oxide, simply as catch vessels; but an alkaline sulphide being needed for the sulphur compounds other than sulphuretted hydrogen, the use of oxide has been almost entirely discontinued, and the purifiers charged with lime. . . . So far as I have gone, the purified liquor has been chiefly used for absorbing carbon dioxide from the gas, though it also absorbs a considerable proportion of the sulphuretted hydrogen. The former impurity is, however, removed to such an extent that the quantity left in the gas as it leaves the scrubbers is too small to be estimated . . . relieving the lime of over half its work and the apparatus of the excessive pressure caused by the caking of the carbonate of lime. . . . At present the purified liquor is used mainly for removing carbon dioxide, leaving the lime to absorb sufficient sulphuretted hydrogen to convert it into sulphide, and so to deal with the sulphur compounds; but we are not going to stop here. . . . Sulphide of ammonia, when free from carbon dioxide, has been proved by experiment to be as effective an absorbent of the sulphur compounds as is the foul lime . . . so that we shall shortly be using 'caustic' liquor for the removal of carbon dioxide and sulphuretted hydrogen; a solution of ammonium sulphide for the obnoxious sulphur compounds; a water scrubber for the remaining ammonia; whilst the existing purifiers will be charged with oxide only as catch boxes; thus cheaply and effectively accomplishing the complete purification of gas in closed vessels without nuisance."[4]

Three years later F. Livesey, of London, confirmed this work, summarizing his findings as follows: ". . . the best purifying results both as to sulphuretted hydrogen and carbon dioxide are obtained by bringing the gas produced from a certain quantity of coal into contact with from 3 to 6 times[5] the quantity of liquor produced from the same quantity of coal, and at the same time subjecting the liquor to a continuous purifying process. . . . Whether the purification of the gas will be improved by concentrating or distilling the ammonia is still an open question, for when strong ammonia is used that impurity is so readily carried forward."

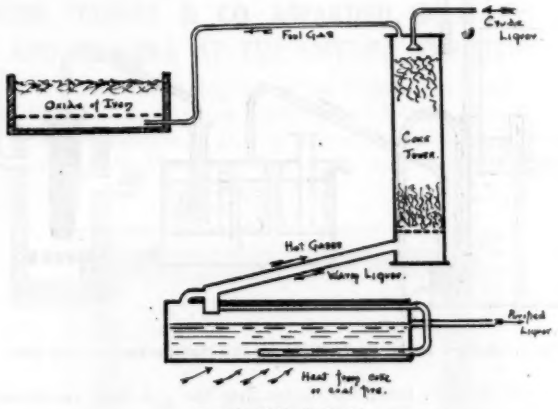


Fig. 4.—Hill, 1869-74.

The efficacy of Hill's process was now generally accepted; and he further improved his method by another patent in 1874, in which he overcame the primary drawback of excessive ammonia losses due to lack of heat control. All that now remained to perfect this method was the utilization of some source of "waste" heat, to remove the expenditure attached to the heating of the liquor; and in 1893 Holgate laid down a plant in Halifax with which he achieved this object.[6] Holgate utilized the heat of the waste gases from the saturator of the

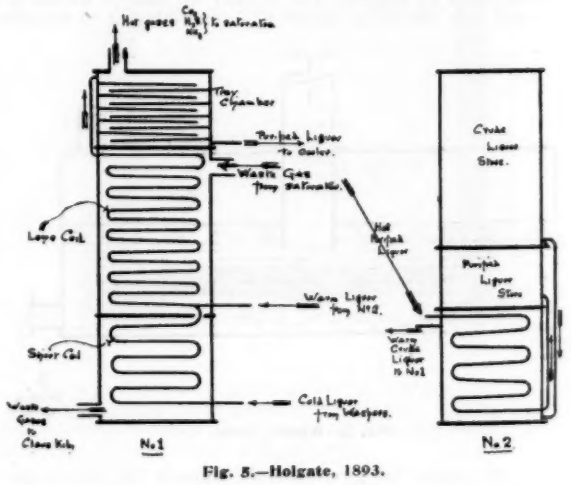


Fig. 5.—Holgate, 1893.

[3] Uriah Haddock, 1819, was the first to use "acidulated water" (*i.e.*, dilute acid) for ammonia extraction; and later, about 1840, sawdust soaked with sulphuric acid was also tried in an endeavour to get intimate contact between the acid and the gas.

[4] Trans. of the British Association of Gas Engineers, 1875, p. 26.

[5] Lewis T. Wright deduced, from an exhaustive study of the hydrogen equivalents of the acids and alkalis in the gas, that the liquor from a certain quantity of coal would require to be re-circulated 3·77 times to engage completely the acids from the same quantity of coal. Ref. "Journal of Gas Lighting," 1886, Vol. 48, pp. 280, 329, 373, and 511.

[6] "Journal of Gas Lighting," 1904, Vol. 87, pp. 526, 601, 657, and 736.

sulphate plate to preheat the liquor fed to the still.[7] He preheated to 200° Fahr. more liquor than was required by the plant, cooled this surplus, and returned it to the washing plant. He thus obtained a continuous supply of decarbonized liquor (at no extra cost) for the extraction of carbon dioxide; reduced ammonia losses by fixing the ammonia in the form of sulphide; and secured a rich feed liquor for sulphate of ammonia manufacture. Further, records show that the sulphur content was kept very low during the working of the plant, and the lime and oxide purifiers dealt with nearly double the quantity of gas.

Reviewing the position at the close of the second period, we find the almost total extraction of the sulphur compounds by ammonia a proved and practicable possibility. In spite of this, the methods of Hill, Livesey, and Holgate had not many adherents; the majority of engineers still preferring to extract what sulphur they could with a weak, non-purified liquor, and to rely on the lime in the purifiers to extract the remainder. In consequence, oxide of iron, which had power to extract only sulphuretted hydrogen, was sparingly used; and dry lime purification costs, with their attendant disposal troubles, remained a big charge on the undertakings and a source of nuisance to the dwellers in the vicinities of gas-works.

THE THIRD PERIOD, 1905-1923.

We have now reached the point where we require to turn to the legislation affecting gas-works to discover why the apparently successful process of purification completed by Holgate and published in 1904 was not adopted by the industry as a solution of the purification troubles which had, up to this time, dogged the steps of the gas engineers.

In 1905 we have the passing of the London Gas Act which "removed liability to forfeiture for sulphur compounds other than sulphuretted hydrogen,"[8] and thus removed the chief factor which had led to the development of the liquor process—namely, the necessity to remove the carbon disulphide and sulphur dioxide from the gas. As early as 1873 the value of gas as a heat developing agent was recognized, but the possibilities opened up by this were not generally appreciated. The advent of the incandescent mantle in 1886, with its "light from heat" principle, coupled with the enormous possibilities of utilizing gas as a heating agent, all tended to a lowering of the illuminating standards. Gas undertakings generally began to apply for powers to allow them to reduce the illuminating power of the gas supplied, while in the London area a reduction from 16 to 14 candles was followed by the introduction of an improved burner, the Metropolitan Argand No. 1, which, by giving a greater candle power per foot than the Referees' flat-flame burner, permitted a still further reduction. This burner was later superseded by the Metropolitan Argand No. 2, which showed a further increase of roughly two candles per foot over the previous standard; and this burner was adopted in 1916 by the Metropolitan Companies.

Owing to the compulsory extraction from the gas of benzole and other hydrocarbon oils, made necessary by the demands of the Great War, legislation in the form of the "Gas (Standard of C.V.) Act, 1916," made it possible for gas undertakings, on application, to change-over from the candle power standard to a heating standard, and the "Gas Regulation Act, 1920," made this voluntary change-over compulsory and universal. This lowering of the illuminating standard and final change-over to a "Therm" standard, which commenced immediately after the London Gas Act, 1905, gradually and finally removed the necessity to extract the carbon dioxide, since the small amount present gave no difficulty in meeting the statutory requirements.

Thus, as the removal of the sulphur compounds (other than sulphuretted hydrogen) and the carbon dioxide became no longer necessary, Holgate's process served no useful purpose, and oxide of iron quickly superseded lime as an absorbent for sulphuretted hydrogen, effecting a great reduction in purifying costs and the removal of the difficulties attending the disposal of the spent lime. The change to modern practice should be now clear, so that at the close of this period we find the majority of gas undertakings removing ammonia with weak liquor followed by clean water, and sulphuretted hydrogen by oxide of iron—as Livesey predicted "in closed vessels without nuisance."

Extensive improvements were made during this time in retort house methods and machinery, and although the aim was to increase the gas yield and the efficiency of the process, engineers consciously or unconsciously achieved an appreciable reduction in the proportion of sulphur compounds present. The chief advances affecting the sulphur compounds were exhauster, retort house governor, and hydraulic main improvements, permitting greater stability of conditions in the retort, thereby reducing the possibility of "overpulling;" better retorts and retort mouthpieces, reducing air leakages and the formation of sulphur dioxide; heavier charges, which caused shorter contact of the gas with the hot walls of the retort; and lastly, improvements in the laboratory assay of coal, which enabled the engineer to select the coal best suited for his particular plant or purpose.

The present problem in purification which confronts us is again the disposal of spent material, namely, the effluent from the ammonia stills, the toxic nature of which has caused the consumer, this time in the guise of the sewage engineer, to complain bitterly of its deadly action on the living bacteria of his sewage beds. The first report on this problem was made by H.M. Alkali Works' Inspector in 1906, and from that time until 1925 has been repeatedly emphasized, until to-day gas engineers have to consider a further revision in methods of purification in order to remove, or reduce, the toxicity of this effluent. A proposed solution of this problem forms the last phase of this paper.

EFFLUENT PURIFICATION.

In the manufacture of sulphate of ammonia we have from the stills an effluent containing phenol, higher tar acids, thiocyanate, and thiosulphate. These bodies absorb oxygen, and if allowed to flow into streams or rivers will remove the dissolved oxygen, which is necessary to aquatic life, from the water. It is now common knowledge that the purification of this effluent from these undesirable constituents is an extremely complicated and costly process, involving extra capital outlay, demanding more ground space for the erection of filters, dephenolating towers, &c.

The earliest work on this subject is, I think, due to Fowler, who in 1906 showed that the bacteria present in the sewage filter beds were not killed by the sulphocyanide and phenol contained in the effluent, provided they were given very small but gradually increasing doses of it. This method is applicable to any works which has plenty of spare ground for the erection of filter beds and effluent storage tanks. Further investigation was commenced under the direction of Dr. Bailey, H.M. Alkali Works' Inspector, in 1921, at Hornsea Gas-Works, where, by blowing hot flue gases up a coke tower, down which was fed the settled effluent (compare Hill's liquor process), a reduction of 42 p.ct. in the phenol content was obtained, while, after three years' work, using a slightly modified dephenolating trough, a reduction of 65 p.ct. in the phenol was achieved.[9]

In the Annual Alkali Report[10] Dr. Bailey, after 4 years' experimental work and investigation, says that "it becomes more and more apparent that the problem must be tackled from the gas manufacturers' side"—in other words "prevention is better than cure." Before examining the problem from this angle, let us consider what is required. First, whatever the method employed, it must not add greatly to the cost of sulphate manufacture, particularly as at the present time this commodity is barely paying for itself; in fact, we might say, it is essential that the method adopted be self-supporting. Secondly, to ensure its universal application the ground space occupied by any plant required must be at a minimum, since quite a large proportion of gas-works have little or no ground to spare.

It is significant that from the very earliest days of the gas industry the crude coal gas has been treated in the various stages of purification in an alkaline atmosphere, due to the gas being kept more or less in intimate contact with "alkaline" liquor until reaching the purifiers. These conditions have proved ideal for the absorption and formation of complex noxious compounds, which up to the present have defied all attempts at their successful removal. The three chief offenders are—

(1) *Phenol Compounds* formed by the reaction of the carbolic acid in the tar with the bases present in the alkaline liquor, forming phenolates.

(2) *Thiocyanates* formed by the reaction of prussic acid and cyanogen with the alkaline bases, chiefly ammonium sulphide in the presence of oxygen.

$$(NH_4)_2S_2 + 2HCN = 2NH_4SCN + H_2S$$
$$(NH_4)_2S_2 + (CN)_2 = 2NH_4SCN + S$$

(3) *Thiosulphates* formed by the inter-reaction of sulphur compounds (of an acid nature) in the presence of oxygen.

$$2(NH_4)_2S + SO_2 + O_2 = 2(NH_4)_2S_2O_3$$

A few figures taken from the reports of H.M. Inspector during the past few years, together with substantiating figures from the Halifax Works, will show much more clearly than words the extremely noxious nature of these impurities.

It will be seen from these tables that in the case of the stored liquor (Table 2) 40 p.ct. of its constituents are noxious *non-volatile* compounds. When using the liquor for the manufacture of sulphate of ammonia or crude ammoniacal liquor, these constituents will, therefore, *remain in the effluent* from the ammonia stills. Then, allowing for a reduction, due to condensed steam and water in milk of lime supplied to ammonia still, of 50 p.ct. (*i.e.*, 2 vols. feed liquor to 3 vols. effluent), the effluent from the manufacture of crude ammonia, at the best, yields an oxygen absorption figure of 33 p.ct.

[7] Parrish. Design and Working of Ammonia Stills, p. 165. "Consideration of the thermal balances reveals that the distillation of gas liquor is self-supporting, assuming all available heat is completely utilized . . . the major portion of the heat is contained in the waste gases leaving the saturator . . . of which . . . 60 p.ct. is utilized in preheating the liquor entering the still."

[8] Section 5, clause 7.

[9] Leamington Priors' Results. Ref. "Gas Journal," 1927, Vol. 177, p. 518.

[10] 62nd Alkali Works' Report, 1925, p. 10.

TABLE 1.—*Samples of Liquor from Condensing Systems. Vertical Retorts.*

NOTE.—The figures in this table are taken from the Alkali, &c., Works' Report, 1923.

—	1 Retort House.	2 Condensers Atmospheric.	3 Tar Washers and Scrubbers (Fed from Storage).	4 Scrubbers Alone (Fed from Storage).	5 Purifiers.	6 Storage.
Temperature of liquor, °C.	61	54	20	21	17	35
Character of liquor	Brown, clear	Yellow, clear	Yellow, clear	Colourless, clear	Brown, turbid	Brown, clear
Composition (volatile constituents, grms. per 100 c.c.)—						
Ammonia—Free	1·45	0·73	2·24	2·11	0·16	1·02
Fixed	0·69	0·14	0·12	0·22	1·76	0·35
Total	2·14	0·87	2·36	2·33	1·92	1·37
Sulphide as H_2S	0·010	0·125	0·285	0·305	0·020	0·080
Cyanide as HCN	*nil*	0·020	0·035	0·030	0·020	*nil*
Constituents "B"—						
Phenol as C_6H_5OH	0·334	0·456	0·220	0·128	0·015	0·327
Thiocyanate as SCN	0·311	0·023	0·143	0·010	8·000	0·216
Thiosulphate as S	0·087	0·007	0·017	0·008	0·397	0·045
Higher tar acids as $C_6H_4(OH)_2$	0·660	0·310	0·175	*nil*	*nil*	0·385
Oxygen absorbed by Impurities "B"— (4 hrs at 27·3° C., parts per 100,000)	1350	1060	610	270	6500	1130

AUTHOR'S NOTE.—It will be noticed that all compounds under the heading "Constituents 'B'" comprise the nuisance forming substances.

TABLE 2.—*Showing Complete Investigation of the Liquors Produced in the Various Plants at Halifax.*

March, April, and May Averages, 1926.

—	Retort House. Liquor from Storage Passing Continuously.	Condensers Atmospheric. Condensate Runs to Storage.	Livesey & Holmes Washers. Water in Last Section Holmes Overflows to Livesey and is there Mixed with Little Liquor from Storage.	Storage Tank. Liquor is Fed to Concentrated Ammoniacal Liquor Plant and also to Hydraulic Main.	Effluent from Still.	
					Concentrated Liquor—no "Devil" Liquor Mixed with Effluent.	
Colour of liquor, &c.	Yellow, clear	Yellow, clear	Yellow, clear	Yellow, clear	Deep Claret, clear	
Composition ("A" volatile constituents, grms. per 100 c.c.)—						
Ammonia—Free	0·815	2·085	0·995	0·815	*nil*	
Fixed	0·420	0·140	0·385	0·410	0·017	*Assuming a Dilution in the Still of 50 P.Ct., Calculated Composition of Effluent will be:*
Total.	1·235	2·225	1·380	1·225	0·017	
Sulphide as H_2S	0·1370	0·3180	0·2320	0·1330	*nil*	
Cyanide as HCN	0·0100	0·0130	0·0150	0·0070	*nil*	
"B" Impurities—						
Phenol as C_6H_5OH	0·3180	0·2960	0·235	0·255	0·161	*0·170*
Thiocyanate as SCN	0·2850	0·2740	0·292	0·272	0·182	*0·181*
Thiosulphate as S	0·2620	0·0500	0·227	0·250	0·152	*0·167*
Higher tar acids as $C_6H_4(OH)_2$	0·1100	*nil*	0·1100	0·140	0·080	*0·090*
Oxygen absorbed by Impurities "B" (4 hrs. at 27·3° C., parts per 100,000)—						
Due to phenol	565	530	420	455	285	*300*
,, ,, thiocyanate	235	225	240	225	150	*150*
,, ,, thiosulphate	225	45	195	215	130	*145*
Other forms (including higher tar acids), by difference	70	15	100	100	65	*65*
Total.	1095	815	955	995	630	*660*

NOTE.—The figures in italics show that practically all of the "Impurities 'B'" are retained in the spent liquor from the ammonia still.

decrease on that of feed liquor supplied to the plant. In the case of sulphate of ammonia plants, this figure is even worse, as the "devil liquor" (containing traces of phenol, higher tar acids, and pyridine) is also very often run to the sewage works.

THEORETICAL CONSIDERATIONS OF THE PROPOSED NEW METHOD.

Now suppose that in place of an alkaline gas liquor we plunge the gas *immediately* it leaves the dip pipe into an acid liquor (sulphuric acid) and keep it in an acid atmosphere until the gas leaves the condenser at atmospheric temperature. Omitting for the moment any bases present in tar, the only alkaline gas present in coal gas is ammonia, which will combine immediately with the acid in the liquor, forming ammonium sulphate. The acid gases present—viz., sulphuretted hydrogen, hydrocyanic acid, carbon dioxide, and sulphur dioxide—being weak acids, will be carried forward without reaction, with the possible exception of sulphuretted hydrogen, which may, together with the ammonium sulphate, form a trace of thiosulphate.

$$H_2S + (NH_4)_2SO_4 = (NH_4)_2S_2O_3 + H_2O$$

With suitable sprays the entire ammonia content of the gas should be recoverable in the hydraulic main and condensers. After passing these, an alkali cream washer could be installed which would absorb the hydrocyanic acid and cyanogen in an easily recoverable form, as sodium or potassium, ferro- or ferricyanide, thus eliminating a very harmful impurity from the town gas. (It is estimated that 80 p.ct. of the corrosion in mains and meters is due to the action of hydrocyanic acid and cyanogen.) This alkali washer will also absorb from 50 to 60 p.ct. of the sulphur compounds—sulphur dioxide, sulphuretted hydrogen, &c.—from the gas, thus lightening the load on the purifiers and reducing the oxide purification costs.

Examining the substances present in the tar fog issuing from the dip pipe in the same manner, we find that the nuisance forming compounds, created when using an alkaline liquor—viz., phenols and higher tar acids—when using an acid liquor will be entirely absent owing to their acid nature. On the other hand, certain basic compounds, dependent upon their partition coefficients in the two solvents, sulphuric acid and tar, will be to some extent absorbed—viz., pyridine, acridine, aniline, quinoline, isoquinoline, &c.—and will have a similar effect on the bacteria beds as the impurities in an alkaline liquor. But with this difference—they can all easily be extracted from the acid liquor; and they therefore offer a much less complicated problem than is the case in an alkaline liquor.

I now propose to describe in detail the plant used for the testing of this theory, together with a summary of the results obtained over a working period of some 60 days.

GENERAL DESCRIPTION OF PLANT.

For this experiment a small coal-testing plant was converted so as to provide, as near as possible, conditions comparable with those existing in the retort house. The plant comprised two horizontal iron retorts in a direct-fired setting; the maximum temperature attainable in the retort being 1700° Fahr.; each retort was capable of carbonizing one charge of 22·4 lbs. per 80 minutes. One ascension pipe was fitted to each retort, each pipe leading into a common ∪-shaped cast-iron hydraulic main. In each dip pipe was fitted a 3/16-in. specially designed split spray pointing towards the main; and in addition a larger

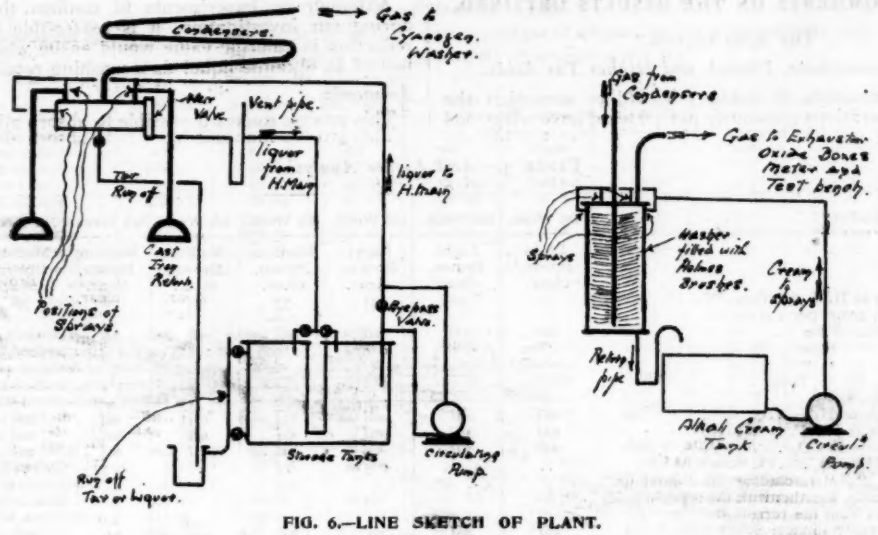


FIG. 6.—LINE SKETCH OF PLANT.

jet was fitted at one end of the main in order to spray all the available gas space. All jets were supplied from a 1¼-in. wrought-iron service pipe at a pressure at the nipple of from 40 to 50 lbs. per sq. in.

All the ammonia was absorbed in the hydraulic main; and to ensure this another small spray was fitted about 3 ft. along the off-take pipe, injecting towards the main. This spray was fitted with a separate valve in order to allow of its shutting off when not required. All the liquor and tar overflowed from the main into two storage tanks, where the tar was separated and the liquor recirculated by pump to the sprays and hydraulic main.

The condensers were of the annular type and were fixed on the wall completely surrounding the plant. They had a slope to the main of 1 in 15 in order that all condensate should, as far as possible, drain back to the main. The gas was then passed to the cyanogen washer, which comprised a large cast-iron cylinder completely filled with old brushes from a Holmes rotary washer. The brushes were split down the centre into a convenient size and fixed to the 3-in. gas main which passed to within 6 in. of the bottom of the cylinder. The gas passed up through the bristles while the washing medium was injected at the top and flowed downwards. The circulating arrangement for this washer consisted of a 50-gallon storage tank from which the alkali cream flowed to the circulating pump which supplied the cream to ⅛-in. sprays, four fixed to spray down the cylinder and four fixed at the side to meet these sprays and thus break up the washing cream into very finely divided particles which descended through the brushes and passed to the storage tank via a 2-in. seal at the bottom of the washer.

The gas passed from the top of this washer to the exhauster, which was of the 4-blade type; from there to two small purifiers charged with oxide of iron; thence to the meter, holder, and test bench.

STRENGTHS AND COMPOSITION OF SOLUTIONS EMPLOYED.

1. *Acid Liquor.*—The acid liquor employed was made from brown oil of vitriol as used in the manufacture of sulphate of ammonia. A 1 p.ct. solution of this acid was prepared, and the hydraulic main and liquor storage tank were filled with it. Throughout the tests a predetermined amount of acid was added each morning to this solution and thoroughly mixed in order to keep the free acid content as near as possible to 0·75 p.ct. The collected tar was drawn off and weighed each day, and a sample taken for analysis.

During the day's working an occasional snap sample was taken of the liquor overflowing from the main, in order to be absolutely certain that no local neutralization was taking place, as if this should occur the value of the test would be nullified. In addition, a representative sample of the liquor was taken each morning before commencing the day's test.

2. *Alkali Cream.*—Although the practicability, &c., of cyanogen washing by means of an alkali cream has been proved previously, it was thought advisable to run out the complete purification process on these new lines. The cream was prepared as in the Davis-Neill process, and an excess soda content of 5 p.ct. was maintained from day to day. The cream was sampled each day, and on attaining a 2 to 3 p.ct. sodium ferrocyanide content was renewed and a fresh charge made up.

DETAILS OF WORKING.

Having first set the acid liquor in circulation through the main, the alkali cream through the washer, and the exhauster running, a charge of 22·4 lbs. of a coal (whose behaviour under ordinary conditions was known) was put into one retort; 40 minutes after this, the other retort was charged with a similar weight and the meter reading was taken. These retorts were then discharged alternately at 40-minute intervals—10 charges in all being carbonized during one day's test. The exhauster was set so as to give as near a level gauge as possible in the hydraulic main; the circulating liquor pump was set to give the maximum overflow possible while maintaining the pressure and not increasing the seals on the dip pipes; while the alkali cream circulating pump was set to give its maximum discharge.

Tests and Analyses carried out during Each Day's Working.

The gas was analyzed at the following points:

A . . Outlet of hydraulic main for:
1. Ammonia.
2. Hydrocyanic acid.
3. Sulphuretted hydrogen.
4. Temperature.

B . . Inlet to cyanogen washer for:
1. Hydrocyanic acid.
2. Sulphuretted hydrogen.

C . . Outlet of cyanogen washer for:
1. Hydrocyanic acid.
2. Sulphuretted hydrogen.

D . . Outlet of purifiers for:
1. Hydrocyanic acid.
2. Sulphuretted hydrogen.

Finally, it was completely analyzed on the test bench every 2 hours, and its heating value obtained every 30 minutes.

Once each day the acid washing liquor was tested for:
1. Total acidity.
2. Iron.
3. Ammonia.
4. Oxygen absorption figure.

The snap samples taken two or three times during each charge were tested for acidity by means of litmus papers.

Once per week a complete analysis of this liquor was made, the following constituents being estimated:

1.	Ammonia	expressed in grms.	NH_3	per	100 c.c.
2.	Sulphide	,, ,,	H_2S	,,	,,
3.	Hydrocyanic acid	,, ,,	HCN	,,	,,
4.	Carbonate	,, ,,	CO_3	,,	,,
5.	Chloride	,, ,,	Cl	,,	,,
6.	Total acid	,, ,,	S	,,	,,
7.	Free acid	,, ,,	H_2SO_4	,,	,,
8.	Iron	,, ,,	Fe	,,	,,
9.	Thiocyanate	,, ,,	SCN	,,	,,
10.	Thiosulphate	,, ,,	S	,,	,,
11.	Phenol	,, ,,	C_6H_5OH	,,	,,
12.	Higher tar acids	,, ,,	$C_6H_4(OH)_2$	,,	,,
13.	Pyridine	,, ,,	pyridine	,,	,,
14.	Oxygen absorption figure expressed as parts per 100,000.				

NOTE.—It was found after the first three weeks that the following compounds were completely absent from the liquor; and in consequence the tests for them were discontinued until final analysis at the end of the investigation:

1. Hydrocyanic acid.
2. Thiocyanate.
3. Ferrocyanide.
4. Sulphide.
5. Carbonate.
6. Higher tar acids.

The only tests that were deemed necessary to be carried out on the alkali cream were—

1. Percentage of free soda (daily).
2. ,, ,, sodium ferrocyanide (weekly).
3. ,, ,, sodium thiocyanate (weekly).

as the behaviour of this liquor was known and of subsidiary importance.

NOTES AND COMMENTS ON THE RESULTS OBTAINED.

1. THE ACID LIQUOR.

Thiocyanate, Thiosulphate, Phenol, and Higher Tar Acids.

From an examination of Table 3 it will be seen that the theoretical considerations previously put forward have withstood the "acid" test of practice. Two out of the four noxious impurities are completely absent from the final liquor, while the phenol and thiosulphate contents have been materially reduced when compared with the analyses of alkaline liquors as shown by Tables 1 and 2. When it is considered that the liquor used has been continuously circulated for a period of 60 days, during which time it has been in intimate contact with tar, no doubt as to the success of the experiment can be raised. Further, no liquor was taken from the circulating tanks during the test period, and no water added, as it was found that evaporation during the nights and week-ends compensated for the volume of liquor made; actually we had slightly less volume of liquor at the end of the test run than at the beginning.

TABLE 3.—*Acid Liquor Analysis*

End of	1st Week.	2nd Week.	3rd Week.	4th Week.	5th Week.	6th Week.	7th Week.	8th Week.
Colour, &c.	Light Brown, clear.	Light Brown, clear.	Light Brown, clear.	Medium Brown, clear.	Medium Brown, clear.	Medium Brown, clear.	Medium Brown, clear.	Medium Brown, clear.
Temperature at H.M. overflow, °C.	37	38	34	33	34	36	36	36
Constituents, grms. per 100 c.c.—								
(1) Ammonia—Free	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
Fixed	0·170	0·451	0·812	1·006	1·224	1·417	1·601	1·792
Total	0·170	0·451	0·812	1·006	1·224	1·417	1·601	1·792
(2) Sulphide as H_2S	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
(3) Cyanide as HCN	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
(4) Carbonate as CO_2	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
(5) Chloride as Cl	..	..	0·510	..	..	0·713	..	0·792
Constituents "B" (including the "noxious" constituents, together with the organic acids and bases from the tar)—								
(1) Thiocyanate as SCN	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
(2) Thiosulphate as S	0·004	0·010	0·016	0·019	0·017	0·021	0·021	0·023
(3) Phenol as C_6H_5OH	..	..	0·101	0·124	0·149	0·178	0·201	0·220
(4) Higher tar acids as $C_6H_4(OH)_2$	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
(5) Pyridine bases	0·058	0·117	0·166	0·220	0·281	0·330	0·379	0·416
(6) Iron	0·1701	0·3035	0·4272	0·3967	0·4118	0·4352	0·4063	0·4217
Oxygen absorbed (parts per 100,000, 4 hrs. at 27·3° C.)	224	385	564·8	734	902	1026	1135	1256

Pyridine and Other Tar Bases.

The new impurities found in the acid liquor are formed by the reaction of the acid with the weak tar bases. Owing to shortage of time we have been unable fully to investigate the behaviour of these compounds; consequently, for the time being, they are all expressed as "Pyridine Bases." It would appear that pyridine is present in such quantities as to lead one to the assumption that its separate recovery may be a sound financial proposition. This, however, must be left for future consideration. For the purpose of this paper it is sufficient to know that the pyridine and other tar bases can be entirely removed by neutralizing the liquor and distilling (see Table 8).

Iron.

Dilute sulphuric acid has a corrosive action on iron. It was thought, however, that the tar film on the interior of the hydraulic main and connecting pipes would serve to protect the iron from this action of the acid. This theory proved correct; the pump and spray connections were of new wrought-iron tube, and until this tube became coated with tar the iron content in the liquor gradually increased. After the first fortnight, this figure remained constant throughout the two months' run; and the wrought-iron sprays, when extracted and carefully examined, showed no appreciable corrosion.

2. GAS.

Temperature.

It will be noted that the average temperature of the gas leaving the hydraulic main showed a decided decrease on the old system of working. This should materially lighten the load on the condensing and tar extraction plants.

Effect on Calorific Value.

The earlier attempts at ammonia extraction by means of acid were condemned owing to the loss of illuminating power effected by this method. In 1840 Croll patented an acid bubbler in which he proposed to use a 2½ p.ct. solution of sulphuric acid for the complete extraction of ammonia. This process was adopted by the Central Gas Consumers' Company of London and several others, and was found to be quite satisfactory. Referring to the effect of acid on the rich hydrocarbons in the gas, Croll stated that "with a weak solution as indicated, the ammonia was effectually removed, and the illuminating power of the gas not injured."[11]

[11] "Treatise on Gas Works," by S. Hughes, 1866, p. 174. Also 1853 edition, pp. 156–164.

Although no experiments to confirm this were conducted during our investigation, it is reasonable to suppose that no reduction in calorific value would ensue when using an acid in lieu of an alkaline liquor as a washing medium.

Ammonia.

This process makes it possible to absorb all the ammonia from the gas, in the hydraulic main, thus using one piece of plant for two purposes and saving capital cost and maintenance of "wet" purification plant.

TABLE 4.—*Alkali Cream Analysis.*

End of—	Coal Carbonized. Cwts.	Free Soda.	$Na_4FeCy_6.10H_2O$ (Grms. per 100 c.c.).	NaSCN.
1st week	10	7·312	0·0193	0·0021
2nd ,,	8	6·406	0·0403	0·0037
3rd ,,	10	5·921	0·0622	0·0043
4th ,,	10	6·042	0·0855	0·0057
5th ,,	10	5·055	0·1103	0·0070
6th ,,	10	4·714	0·1308	0·0091
7th ,,	8	6·786	0·1539	0·0110
8th ,,	10	5·233	0·1740	0·0130

Cyanogen Extraction.

Here again a big saving on maintenance costs, due to less corrosion of mains and meters, is indicated by the extraction in marketable form of the hydrocyanic acid and cyanogen contained in the gas. In addition to this, the sulphuretted hydrogen is reduced by some 60 p.ct., thus lengthening the life of the dry purification plant, or alternatively reducing the size and cost of this plant.

TABLE 5.—*Analysis of Tar.*

NOTE.—In the first place it was decided to omit the tar from the investigation. However, after the first few days' working, it was noticed that the liquor had a washing action on the tar; a heavy scum of a gelatinous nature collecting on the surface of the liquor in the circulating tanks.

Owing to lack of time the investigation of this scum has of necessity had to be omitted, though analyses of the tar produced show a decided decrease in the free carbon content, giving a much-improved tar.

Each day's sample was mixed, and once per week a sample was withdrawn and tested.

As these analyses agreed within a degree or two, an average over the whole 60 days is given below, together with a representative analysis of the tar produced in the same plant when working under the old conditions.

—	Acid Process.	Old Process (Standard Practice).
Specific gravity at 60° C.	1·110	1·195
P.Ct. free carbon	7·6	21·2
P.Ct. H_2O	11·2	6·0
Light oil—		
(Up to 170° C.)	3·5	4·4
Middle oil—		
(170° C. to 230° C.)	0·7	1·2
Heavy oil—		
(230° C. to 270° C.)	5·5	6·8
Anthracene oil—		
(270° C. to 360° C.)	15·6	16·0
Pitch (including free carbon)—		
By difference	63·5	61·6

TABLE 6.—*Extraction Table.*

Showing the quantities of—(1) NH_3, (2) HCN, (3) H_2S present in the gas at various points of the purification plant.

Results expressed in grains per 100 c.ft. (Corrected to N.T.P.)

—		1st Week.	2nd Week.	3rd Week.	4th Week.	5th Week.	6th Week.	7th Week.	8th Week.	Average.
Outlet hydraulic main—										
NH_3	New method	*nil*	*nil*	*nil*	*nil*	Trace	*nil*	Trace	*nil*	*nil*
	Old method	*104·3*	*122·7*	*120·3*	*114·9*	*135·7*	*130·8*	*140·1*	*129·6*	*124·8*
*HCN	New method	45·73	50·91	49·30	54·29	56·84	49·30	54·71	48·00	51·13
	Old method	*39·71*	*30·84*	*41·27*	*38·59*	*37·21*	*37·94*	*34·36*	*37·50*	*37·30*
H_2S	New method	737·3	751·2	740·0	700·3	751·2	770·1	747·3	714·2	738·8
	Old method	*594·2*	*606·6*	*616·8*	*610·6*	*614·0*	*590·3*	*614·2*	*571·3*	*602·2*
Inlet cyanogen washer— (NOTE.—In old method, scrubber fed with water was used in place of above.)										
NH_3	New method	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
	Old method	*57·34*	*63·87*	*60·34*	*55·05*	*68·21*	*65·73*	*66·86*	*62·71*	*62·49*
*HCN	New method	45·94	50·41	49·32	54·30	56·30	49·17	54·72	48·14	51·03
	Old method	*28·16*	*25·31*	*30·20*	*30·16*	*28·37*	*27·46*	*27·02*	*29·34*	*28·26*
H_2S	New method	724·7	717·3	738·4	692·1	720·0	756·3	717·5	698·8	720·6
	Old method	*522·4*	*530·1*	*581·3*	*530·1*	*549·2*	*530·1*	*517·3*	*498·0*	*532·9*
Outlet washer—										
NH_3	New method	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*	*nil*
	Old method	*1·172*	*0·742*	*1·201*	*1·342*	*0·957*	*1·014*	*1·172*	*1·464*	*1·133*
HCN	New method	0·217	2·304	1·423	1·707	0·842	1·114	1·063	0·987	1·206
	Old method	*20·91*	*19·17*	*18·20*	*20·13*	*19·99*	*20·24*	*18·06*	*19·43*	*19·52*
H_2S	New method	123·6	135·9	127·6	110·5	155·5	154·0	141·5	118·8	133·4
	Old method	*469·5*	*448·7*	*470·2*	*442·2*	*439·0*	*486·0*	*474·0*	*434·8*	*458·0*
Outlet purifiers—										
HCN	New method	*nil*	1·001	0·342	0·474	*nil*	*nil*	*nil*	*nil*	0·227
	Old method	*15·19*	*13·20*	*12·91*	*13·07*	*10·90*	*14·36*	*15·17*	*13·29*	*13·52*
H_2S	New method	*nil*	*nil*	*nil*	1·971	1·450	*nil*	0·926	*nil*	0·543
	Old method	*4·971*	*3·454*	*2·227*	*2·227*	*3·780*	*4·454*	*3·036*	*5·314*	*3·685*

*NOTE.—The slight difference in these figures is due to the impossibility of using the same gas for two tests.

TABLE 7.—*Bye-Products Recovered—*

viz., (1) NH_3 expressed as $(NH_4)_2SO_4$ lbs. per ton of coal carbonized.
(2) HCN ,, ,, $Na_4FeCy_6.10H_2O$,, ,, ,, ,,
(3) H_2S ,, ,, S ,, ,, ,, ,,

Figures in italics show recovered bye-products when working the plant under the old conditions—*i.e.*, with an alkaline liquor and no cyanogen extractor.

Average of Weeks' Tests	1st Week.	2nd Week.	3rd Week.	4th Week.	5th Week.	6th Week.	7th Week.	8th Week.	Average.
C.ft. of gas made per ton of coal carbonized (corrected) NOTE.—11,000 c.ft. per ton taken for purposes of calculation.	10,942	11,170	11,094	10,873	11,241	11,021	11,070	10,917	11,000
NH_3 (in hydraulic main)—									
New method	16·81	27·79	25·67	18·96	21·55	19·06	18·17	18·87	20·86
Old method { *Hydraulic main*	*16·14*	*17·42*	*15·94*	*16·27*	*18·01*	*15·74*	*16·32*	*17·76*	*16·70*
Old method { *In scrubber*	*3·53*	*3·97*	*3·72*	*3·38*	*4·24*	*4·07*	*4·12*	*3·86*	*3·86*
HCN (in cyanogen washer)—									
New	0·193	0·210	0·219	0·233	0·248	0·205	0·231	0·201	0·218
Old	*nil—in recoverable form.*								*nil*
H_2S (in oxide purifiers)—									
New	12·80	14·05	13·20	11·22	15·95	15·95	14·53	12·30	13·75
Old	*48·10*	*46·20*	*48·50*	*45·50*	*45·10*	*49·70*	*48·75*	*44·45*	*47·04*

NOTE.—Volume of storage tanks, 20 c.ft. = 120 gallons = 560 litres.

NOTE.—In Tables 6 and 7 will be noted some figures in italics. These figures are taken from a two months' run previous to the acid washing investigation. The same class of coal was used, and other conditions were the same with the following exceptions:
(1) An alkaline liquor was used in the hydraulic main. The NH_3 being extracted in the usual tower-type scrubber—as in standard practice.
(2) No cyanogen extractor was used.
(3) The liquor made each day was run to stock, and not circulated.

3. TAR.

Notes will be found attached to Table 7 in respect of this bye-product. A note should be added to these, however, respecting the miscibility of the tar. The tar separating from this acid liquor gives a perfectly clear miniscus against the liquor, thus giving *absolute* separation of the tar and liquor. This confirms the findings of Dr. Bailey that "free ammonia . . . favours the emulsification of tar . . . fixed ammonia salts, on the other hand, have a *contrary effect.*"[12] This should prove a decided advantage when pumping or feeding liquor to sprays or ammonia stills.

TREATMENT OF ACID LIQUOR.

Our first observation on examination of Table 8 is that, *prima facie*, we have succeeded in producing an infinitely more noxious

[12] 61st Alkali Report, 1924, p. 20.

TABLE 8.—*Acid Liquor after Preliminary Treatment.*

—	1.	2.	3.	4.	—
Colour of liquor	Greenish Brown, turbid.	Very Pale Straw, clear.	Very Pale Straw, clear.		NOTE.—The liquor used in these estimations was taken from the circulating tank after the last day's working. The complete analysis of this liquor will be found in Table 3 in the column marked "8th Week."
Composition—					
"A" volatile (grms. per 100 c.c.)—					
Ammonia, fixed	0·017	*nil*	*nil*	*nil*	No. "1."—Excess of $Ca(OH)_2$ added to the sample and the whole boiled.
"B" Impurities—					
Phenol as C_6H_5OH	0·217	0·208	0·044	0·030	No. "2."—Excess of $Ca(OH)_2$ added, boiled, and filtered. To the filtrate a little more $Ca(OH)_2$ was added and the whole boiled in a current of steam until all traces of NH_3 were absent. The whole was then filtered, cooled, and made up to the original volume.
Thiosulphate as S	0·024	0·024	0·021	0·014	
Pyridine as C_5H_5N	0·020	*nil*	*nil*	*nil*	
Iron	0·4217	*nil*	*nil*	*nil*	
Oxygen absorbed by Impurities "B" (parts per 100,000)—					
Pyridine	38·60	..	..	..	No. "3."—The liquor was first boiled in a current of steam for a short time (100 c.c., 10 minutes). It was then treated as No. "2."
Iron	60·20	..	..	..	
Thiosulphate	20·54	20·54	17·97	11·96	
Phenol	386·30	370·24	78·32	40·40	
Theoretical total	505·64	390·78	95·29	52·36	No. "4."—This analysis is calculated from column "3," assuming a dilution of 50 p.ct. in the still.
Total (by test)	489	371	90	44	

liquor than was ever produced when working with an alkaline liquor in the previous way. After further study, however, it will be noticed, first, that the same liquor has been in intimate contact with gas and tar for the full period of the test, and secondly, that the oxygen absorbing constituents are of a vastly different nature. Since phenol is an acid, it cannot be in such close combination with other salts as when present in an alkaline liquor, and we can, therefore, consider it as "free" phenol, capable of being removed by simple steam distillation; and as recently shown by Dr. Pruss, it is easily recoverable by benzole washing as a "marketable product."[18]

On turning our attention to the next impurity, pyridine, we find that this also can be easily and completely removed by neutralization with milk of lime and steam distillation, leaving only one impurity to deal with—namely, thiosulphate. This impurity constitutes a very small percentage of the whole, being equivalent to only 20 parts of oxygen or 1·59 p.ct. of the oxygen figure in the untreated liquor; and in practice it should be considerably less than this, since it is chiefly due to the excessive exposure of the liquor to the atmosphere during the course of the investigation.

Dr. Pruss has shown the extraction of phenol from coke liquor by benzole washing to be both practicable and profitable. Applying this method to the acid liquor, we should gain a distinct advantage, since this liquor can be worked up to a much higher degree of concentration than is possible with an alkaline liquor, and would, therefore, give a larger yield of phenol per gallon washed. In the case of small works where phenol recovery is not desirable, it will be necessary to wash the small amount of "devil liquor" obtained, since this will contain the major portion of the phenol, the remainder being left in the sulphate or mother liquor.

In order to obtain a colourless effluent with an oxygen absorption figure of from 30 to 40 parts per 100,000, it is only necessary to allow the effluent to stand, to settle out the lime salts and the hydrate of iron.

Conclusion.

Although the investigation is by no means exhaustive or complete, sufficient data have been obtained to prove the theory of the method and to suggest that its commercial application would result in extensive financial gain. Quite apart from the economies in gas purification plant, decreased meter repair costs, &c., the liquor itself offers another distinct source of revenue from the recovery of its phenol and pyridine contents.

The author wishes to acknowledge his indebtedness to the work of those to whom he has referred in the text and to his assistant, Mr. Wilson. His thanks are also due to his Chief, Mr. W. B. McLusky, for his kind encouragement, to the Gas Committee of the Halifax Corporation for the opportunity of carrying out the experiments, and to the Gas College, Halifax, for access to their extensive library.

Discussion.

The President said that, knowing this paper would excite general interest, he invited his old friend, Mr. R. H. Clayton, of Manchester, whom he regarded as one of the greatest authorities upon the subject, to open the discussion.

Mr. Clayton said he must begin by expressing his appreciation of the honour of being asked to open the discussion upon a paper of this character at a meeting of the Institution. Mr. Pickles had covered so much ground that it was difficult to know where to start, and he must confine his remarks to the essential points. The really important part of the paper was the third section, which dealt with the very pressing question of effluents. He agreed thoroughly with the view put forward that prevention was better than cure, because, when impurities had got into the liquor, elimination was a costly process. In 1927, he and others studied very carefully the system of washing the crude ammoniacal liquor with benzole. He went over to Germany and examined the system which was in operation there. Really it was applicable only to very large installations, several of which were working abroad and were giving great satisfaction. There were coke ovens in Germany which dealt with 250,000 tons per year, but the impurities eliminated were only the phenolic bodies, of which 80 p.ct. could be readily removed. Other contaminations, so often present in large quantities in gas-works liquors—namely, thiosulphate and sulphocyanide—were not touched. Not all liquors responded to the benzole treatment. Some of them were emulsified badly, and had to be acidified before clear separation could be obtained.

The process put forward by the author was one of several alternatives. It resembled the direct recovery process at present in use in coke oven practice and also in Mond gas plant. He himself had done work on somewhat similar lines. The experimental plant on which the results had been obtained was a small horizontal plant working at low temperatures (*i.e.*, 930° C.), and therefore the products were not quite comparable with those obtained in large installations of vertical retorts with steaming. The higher tar acids would be low, and also the cyanogen bodies. According to the figures, only 2·4 lbs. of prussiate was produced per ton of coal, as against over 4 lbs. in the usual installations, vertical and horizontal.

He would deal first with the sulphuretted hydrogen, which in the small plant was largely caught in the cyanogen washer. Any sulphur caught in the cyanogen washer other than that necessary to form sulphide of iron to combine with cyanogen bodies was fatal to the economical recovery of cyanogen. Every ton of sulphur recovered by copperas was equivalent to over £15 for copperas alone per ton of sulphur. The disposal of the sludge and the washing to recover the prussiate were additional expenses. The effect of using excess of copperas due to tar fog getting forward into the cyanogen washer had in the past made this cyanogen recovery process generally uneconomical.

While discussing the question of recovery, it might be as well to inform the meeting that the adoption of this process on a large scale was impossible from an economic point of view. The total amount of prussiate required in the English market per annum was a little over 1000 tons, and any one large gas-works could itself provide that quantity. The same remark might apply to low-temperature carbonization where great claims were made for the phenolic bodies present in the air. As there was no outlet for prussiate on the scale vizualized, it was unnecessary for him to discuss the cost of manufacture, on which he could also offer a great deal of criticism.

A statement was made in the paper about the corrosive action of prussic acid on mains and meters. He would refer the members to a communication by Mr. H. E. Williams in the "Journal" for June 20, 1923, which conclusively proved that prussic acid had no effect on iron. Recently he had seen the inside of a gasholder into which gas which contained a considerable amount of prussic acid had been passing for many years, and there was not the slightest trace of corrosion due to that chemical. The corrosion was due to carbonic acid and hydrogen forming ferrous carbonate. This was later transformed into prussian blue by the hydrocyanic acid in the gas. It was fairly obvious that carbonic acid was doing the corrosion in the presence of oxygen from the fact that, taking the quantity of carbonic acid present in the gas compared with the prussic acid, and also calculating their acidic values, the acidity due to the carbonic acid was many hundred times that of the possible prussic acid in the gas. On the other hand, non-ferrous metals, such as copper or nickel alloys, in the meters were subject to attack by prussic acid; and this action was emphasized in the presence of traces of ammonia. Therefore it was highly desirable to keep the prussic acid in the gas down to a minimum.

They had recently done a considerable amount of work on this subject, and found that in gas-works where the purifying conditions were normal, the prussic acid passing forward was reduced to a negligible quantity—namely, one to two grains. In some cases it was entirely absent. They were still working on the subject. They found that prussic acid passed in all cases where the oxide was acid or where ammonia was deficient, particularly if the oxide was worked very dry. Excess of oxygen might also affect the absorption, as HCN was only caught by ferrous sulphide, and not by the iron oxides.

Therefore he would prefer not to manufacture prussiate according to the process outlined by Mr. Pickles, but to catch the cyanogen in the boxes. That was an inexpensive operation and entailed no extra expense as regards plant or supervision.

It was not generally known among gas engineers how much prussic acid was passing forward into the town, as a test was seldom made. He had with him two towers containing nickel sodium, which chemical acted with great rapidity on gas containing prussic acid, but free from H_2S. By passing 100 c.ft. through one of these towers, after a little experience it was easy to determine the prussic acid contamination in the gas without any laboratory test. This test was not perhaps in line with the paper; but the question of corrosion had been raised, and it would help members to see for themselves what was the condition of their gas.

He came now to the main substance of the paper—namely, contamination of the ammonia liquor with phenolic bodies, pyridine, sulphocyanide, and thiosulphate. It was now well known that contamination with thiosulphate and sulphocyanide was due to excessive circulation of the liquids and standing in the well. Each time the liquor was brought into contact with the gas a certain amount of prussic acid was absorbed, a certain amount of free sulphur was liberated, and a certain amount of ammonium sulphide was oxidized to thiosulphate, due to the oxygen in the gas, not due to SO_2 in the gas. This SO_2 could not exist in the presence of H_2S.

They had tested ammonia liquors from different installations, and in any installation where shock cooling was used and the liquors were not circulated, the amount of thiosulphate and the sulphocyanide could be kept down below 0·1 p.ct., which was not an excessive amount. The liquors of some installations contained 1·8 p.ct. of sulphocyanide and a corresponding amount of thiosulphate, with small quantities of prussic acid passing forward out of the washers. Of course, this was a very serious matter for the sewage authorities.

Coming to the direct acid wash described in the paper, the results as regards sulphocyanide and thiosulphate were in accordance with coke oven practice of direct ammonia recovery, and had been corroborated by themselves (Mr. Clayton and his colleagues). It appeared from the paper that the phenol content increased every week, and corresponded practically to the total phenol content of the tar. He was of opinion that this content would have risen to 0·5 or 0·6 p.ct. if the experiment had been continued for long enough. It was difficult to understand why the higher tar acids were absent. One would imagine them to be equally soluble in the solution. There was no statement in the paper as to whether higher tar acids were present in the ammonia liquor working in the old way; and, of course, higher tar acids were not produced to the same degree in this experimental plant as they were in vertical retort installations, and they did not appear in the liquor to the same extent. The main point which caused one to think was the fact that the liquor had not increased in volume. In large-scale practice this must be the case. Therefore, the ammonium sulphate solution would be very weak for economical working if one had to evaporate the salt out. On the other hand, evaporation would recover the phenol and the pyridine, to set against the evaporation cost. Unfortunately, here again the market for pyridine was very limited, since the American market had gone, due to the discontinuance of the use of pyridine for denaturing alcohol. In very few tar works was pyridine recovered at present.

Comparing the process outlined by the lecturer with coke oven

[18] "Gas Journal," Aug. 21, 1929, pp. 404-407.

practice with direct recovery—as in the Otto plants—the coke oven condensate, after recovering the ammonia, contained up to 0·6 p.ct. of phenol. In this process, of course, the tar was previously eliminated to a large extent by means of tar sprays, while the phenol was volatile at the temperatures worked. On the other hand, higher tar acids were not volatile.

They had found—and it was corroborated by other workers—that the higher tar acids were wholly contained in the tar fog. If this tar fog was eliminated before the aqueous vapour condensed, the ammoniacal liquor would be free from those bodies, and would remain water-white when exposed to the air. Working on those lines, they recently installed a small column filled with Raschig rings—so avoiding fans, pumps, &c.—working at about 180° Fahr., and by means of the column they eliminated all the tar fog in the gas. The condensate remained water-white and only contained pure phenol. Later they connected to this column an acid wash working with acid to get a 40 p.ct. solution of sulphate of ammonia, which did not crystallize on cooling. After this acid treatment the condensate contained no sulphocyanide or thiosulphate in appreciable quantities, and was also free from phenol. They therefore presumed the phenol was caught by the light tar oils floating on top of the acid wash. They thought they had solved the problem. However, a continuation of the work showed that the acid wash absorbed the phenol and became rapidly saturated, as was apparently taking place in the results put before the meeting. After saturation-point had been reached, the phenol went forward with the hot gas and appeared in the aqueous condensate. This must happen also in the new process, and there would always be an equal amount of phenol to deal with. Later they determined that if, after the first hour, a second tower were placed, also filled with rings and kept above the dew-point, down which were run tar oils or tar previously heated to 250° and so de-phenolated, the phenol in the condensed liquor was reduced about 50 p.ct., and it gave a final effluent of 425 parts of oxygen to 100,000 parts of liquor, working on a vertical retort setting and making 18,000 c.ft. of gas to the ton. Looking at the process as a whole, he considered it advisable previously to eliminate the tar fog, and keep the gas above its dew-point before treating with acid solution.

As regards the utilization of weak acid liquor and its non-action on metal, this seemed rather a dangerous assumption; but no doubt corroborative evidence could be obtained from engineers' experience in that direction. Another trouble would be the acidity of the tar running to the tar works. It seemed to him preferable to eliminate the tar before acid treatment, keeping the gas above its dew-point and passing the gas direct through the sulphuric solution by which means the two recoveries would be kept separate. In considering this matter, one might go further, and contemplate a comparative scheme which would arrange for one central works to collect the solutions from distant gas-works, and be the sulphate plant for the district. With the future outlook of sulphate of ammonia, the most economical method of handling the problem must be considered. All that the gas engineer would then have to do would be to make a 40 p.ct. solution of sulphate of ammonia; he would then be free from further trouble. The sulphate would all come from one place, and it would be a very much cheaper proposition than every works handling its own make.

The reduction of the phenol vapour passing forward could be effected by washing with de-phenolated tar, or tar oils, which would be a closed circuit. Or the aqueous condensate could be treated with benzole with greater efficiency than washing the phenol out of the ammoniacal solution. To strip the free phenol out with steam would suit a moderate-sized works the best, but no figures were given.

One of the main advantages of acid wash, whether on the cold gas after the scrubbers, or direct on the hot gas after it left the hydraulic main, would be the elimination of the water at present used to complete the ammonia recovery. The addition of this water greatly increased the volume of the ammoniacal liquor produced, and so the quantity of impurities sent away in the effluent. Every gallon of pure water introduced into the system became as fully saturated with impurities as the original condensate.

Mr. A. L. Holton (Manchester) said reference had been made to Dr. Fowler's work. He had the pleasure of working with Dr. Fowler in the investigation of the bacteriological treatment of waste liquors, and he wished to point out that those results were obtained in what was now known as the activated process. So there would be a further improvement on the results given in the paper, more particularly, he thought, in the area of the bed for the amount rather than in the final purification; 100 p.ct. purification of the waste liquor effluent was a very doubtful proposition under the bacteriological process. Nowadays sewage authorities were beginning to want a figure which it was very questionable if it could be got in that process. Mr. Clayton had mentioned the fact that the experiments were done on horizontal installations; the proposition would be entirely different in vertical installations. Where the gas was dipped into a liquor, or into its own solution—in this case into an acid solution—there was a daily process of fishing out the tarry sediment and the accumulation of coal dust, and so on. It seemed to him the process was a little difficult. He was particularly interested in the fact that Mr. Pickles was connected with the Halifax Works. Many of them would remember with pleasure the Presidential Address which Mr. Holgate gave about thirty years ago, in which he dealt particularly with the condensation of coal gas. Perhaps he was a little before his time, but to-day attention was again being concentrated upon the purification of coal gas in order to get rid of the final effluent from the stills.

Mr. W. Buckley (Manchester) remarked that illustration No. 2 showed a washer said to have been invented by Mr. Winsor. Mr. Winsor was like a modern company promoter, he picked the brains of other people; and he (Mr. Buckley) was rather sorry the lecturer had not given credit to the gentleman to whom credit was due for the introduction of the use of lime for the purification of coal gas. That was Dr. Henry, of Manchester, who, in 1808, had interested himself so much in gas that he was analyzing gas made from coal, indiarubber, resin, whale oil, paraffin oil, and a variety of other things. There was evidence of this in notes in his own handwriting.

This should be particularly interesting to Mr. McLusky. Clegg was generally put down as the first engineer of the present Gas Light and Coke Company, but in fact he followed Winsor, Accum, and Hargreaves. He worked with William Murdoch. In 1807, he built a gas-works to supply gas to the establishment of Mr. Henry Lodge, at Sowerby Bridge, and it was claimed that that mill was lighted with gas prior to William Murdoch erecting the apparatus for the lighting with gas of Phillips' mill in Salford.

Present-day engineers would do well to read a most excellent book published by Samuel Hughes in 1853, price 3s. It contained some interesting information about Dr. Henry. The latter made his name world-famous by his work on the solubility of gas in water. He worked in conjunction with Dalton, and much of their work was published in the Proceedings of the Manchester Literary and Philosophical Society. One of the frescoes in the Manchester Town Hall showed Dalton collecting marsh gas. A notebook (produced by Mr. Buckley) recorded some of the experiments carried out by Dalton and Henry in determining the composition of carburetted hydrogen, as it was then called, now known as marsh gas. There were also notes about the production of oil gas. Henry made oil gas; Dalton did so also. An original paper by Dalton (produced by Mr. Buckley) stated that he found the best method of producing oil gas was to allow the oil to drop on to a hot iron plate.

Another interesting fact was that, in 1823, Dr. Henry, in a report made to Gas Commissioners in Manchester, stated that Manchester gas was entirely free from sulphuretted hydrogen. He (Mr. Buckley) had the rough notes which Dr. Henry made and which formed the basis of that report. Under date Feb. 25, 1824, after comparing the results obtained at the Manchester Gas-Works with those obtained at several private establishments in the town, he stated: "I find that the gas now prepared at the public works is fully equal in quality to that of any private establishment which I have tried, though at some of the latter great pains is taken both in preparing and purifying it." He (Mr. Buckley) believed Clegg used lime in the gas-holder tank, and had a series of paddles to turn the lime round in the water. The difficulty was to get rid of the "blue billy," as it was then called; and he decided to put it in separate vessels. Dr. Henry and Clegg worked in close association. Mr. Buckley added that some day the original notes of Dr. Henry which he had shown would go to the Manchester Literary and Philosophical Society.

Mr. W. J. Smith (Bolton) observed that, if the paper had no other result than eliciting Mr. Clayton's contribution, it would have been worth the time spent upon it.

Mr. H. P. Lupton (Liverpool) remarked that Mr. Pickles said the acid solution in the hydraulic main got a better separation of the tar from the liquor; yet in his analysis of tar he gave in his acid method a water content of 11·2 p.ct., whereas in the ordinary ammoniacal method the water content was 6 p.ct. An analysis like that should not be quoted if Mr. Pickles got the separation which he claimed from the acid liquor. Another point was the big drop in the free carbon content of the tar. The paper stated that the same quality of coal was used under the same conditions during the two processes; yet by simply changing the nature of the liquor from an ammoniacal solution to a dilute acid solution, he claimed a drop of from 20 or 21 p.ct. of free carbon down to 7 p.ct. Many engineers would be very pleased if they could so easily reduce the free carbon content of the tar from horizontals by a change in the nature of the liquor in the hydraulic. A drop from 21 p.ct. to 7 p.ct. was astounding, considering that no change was made in the carbonizing conditions.

Ammoniacal liquor absorbed a certain amount of acid gases—carbon dioxide and sulphuretted hydrogen. Mr. Pickles was going to deal with the latter in his alkali washer, but the CO_2 content of the gas would not be reduced, and consequently the final gas would have a higher percentage of CO_2 than would normally be the case. Carbon dioxide helped in the corrosive action of the gas. Then in his process Mr. Pickles took out all the ammonia, so that the ammonia was not allowed to go forward to the purifier. What effect had the absence of traces of ammonia upon the purification by iron oxide? Then, if the same coal was being used and conditions were the same, why did Mr. Pickles get a decrease in the ammonia yield from the coal when using the new process?

Another puzzling point was that Mr. Pickles claimed the condenser would have less work to do owing to the fact that the temperature of the gas would be lower with his process than it was with the ordinary ammoniacal process. He (Mr. Lupton) could not see how that was going to happen. If there was an acid solution in the hydraulic and the ammonia was absorbed, surely the tendency would be for the temperature in the hydraulic to be increased rather than decreased, owing to the heat of the solution of the ammonia in the sulphuric acid.

Mr. Clayton had dealt fairly well with cyanogen. In the particular case of the cyanogen washer, Mr. Pickles stated that he got a reduction to about 600 grains per 100 c.ft. when gas was purified by means of his alkali cream prepared as in the Davis-Neill process. If he used that process he would generate a further amount of CO_2 which was going to be in the final gas. Further, what did Mr. Pickles propose to do with the sulphur which was absorbed in his alkali cream? Was he going to lose it? How was he going to recover it? If he was not going to recover it how was he going to get rid of his spent liquor from that particular alkali washer?

Mr. David Vass (Perth) said that previous speakers had raised a number of points that he wished to put to Mr. Pickles. According to the theory of the paper a pure ammonia sulphate would be formed in the hydraulic main. In practice what would be the effect if, instead of having a rising condenser from the hydraulic main, they had the condenser dropping? Would it mean that some of these noxious compounds would be formed in the condenser and in the main leading from the hydraulic main? The point was, Where were these noxious compounds formed?

Reference had been made to the question of carbon dioxide. They

were trying to get rid of the noxious gases. Was the method suggested, of recovering those by a washer of this sort, the best method, or should they be allowed to go forward to the purifier box and be recovered there? He took a strong attitude in regard to the change-over from lime purification to purification by oxide leaving out lime; but as time went on he was beginning to be converted to the idea that they must fall back upon lime as a purifying substance. He believed that lime in some form—whether admixed with oxide or in separate layers and treated separately—would assist in the removal of the CO_2, and in getting rid of the moisture from the gas, and thus eliminate many of the evils that gas engineers were troubled with in modern distribution systems. He had had that in his mind for some years, and at present was taking steps to try experiments in lime purification. The experience of those who experimented on the same lines, and the results they obtained, whether favourable or otherwise, would be of great benefit to the industry.

Mr. W. M. Carr (Stretford) said that the subject with which Mr. Pickles had dealt so cleverly was a very wide one, and the experiments were extraordinarily interesting. Personally he did not think the problem of ammonia purification could be solved successfully by washing, or removal at the outset with a weak acid solution, because they were still left with a large volume of weak ammonia sulphate liquor to deal with. Where they had inefficient scrubbing apparatus and a large volume of weak ammoniacal liquor, great difficulties were presented, especially when ammonia sulphate was of such a low market value. Mr. Clayton referred to washing with a 40 p.ct. acid solution. But even so the tar fog had to be removed first of all, and he did not know any mechanical means whereby the tar fog could be entirely eliminated prior to acid washing without some condensate and ammoniacal liquor. They could not get a useful acid solution without having some ammoniacal liquor left to be dealt with. Mr. Pickles stated: "It is estimated that 80 p.ct. of the corrosion in mains and meters is due to the action of hydrocyanic acid and cyanogen." He thought that statement was rather exaggerated; many of them believed that carbon dioxide had a good deal to do with internal corrosion. There were other points on which many of them would disagree with Mr. Pickles.

The Author's Reply.

Mr. Pickles, replying to the discussion, observed that he could not say much in reply to Mr. Clayton, who had a much wider experience on the chemical side; but he wished to deal with two points which were raised again in the course of the discussion. The first was the question of dealing with the ammoniacal liquor which would be produced. He had made a comparison with the present method of dealing with it in a sulphate of ammonia plant, assuming in each case a production of 50 gallons of liquor of 1·6 p.ct. ammonia per ton of coal carbonized. That was equivalent to 31·04 lbs. of sulphate of ammonia per ton. According to Parrish ("Design of Ammonia Stills," p. 162), 260 lbs. of steam was required per 100 gallons of liquor of 1·6 p.ct. ammonia. For 50 gallons it would be 130 lbs. Then $\frac{130 \times 2240}{31{\cdot}04} = 9381$ lbs. of steam per ton of sulphate of ammonia = 721·5 lbs. of solid fuel per ton of sulphate of ammonia, or $\frac{130 \times 1000}{13{,}000} = 10$ lbs. of solid fuel per ton of coal carbonized (calorific value of fuel 13,000 B.Th.U. per lb.)

In the other case they had to evaporate down the 50 gallons of liquor of 1·6 p.ct. ammonia. It was to be reduced to a 50 p.ct. solution for salting (Lunge, "Coal Tar and Ammonia," p. 959)—*i.e.*, 48·5 gallons to be evaporated per ton of coal carbonized.—$\frac{48{\cdot}5 \times 1000}{13{,}000}$ = 37·31 lbs. of solid fuel per ton of coal carbonized, or 2·691 lbs. of solid fuel per ton of sulphate of ammonia. It was approximately one-fourth of the amount required in the present method.

Then to compare the cost. In the present method they had 9381 lbs. of steam per ton of sulphate of ammonia.

	s.
$\frac{9381}{2240}$ tons steam at 5s. per ton = 4·19 × 5s. . . .	20·95
Lime, 3 cwt. at 35s. per ton	5·21
Water, 500 galls. at 8d. per 1000	0·33
Sludge removal, 5 cwt. at 1s. per ton.	0·25
Still cleaning, &c.	0·64
Steam, oil, &c.	0·25
	27·6

With the acid method the cost per ton of sulphate would be almost three times as much as by the alkali method.

$$\frac{35{,}000}{2240} = 15{\cdot}6 \text{ tons at 5s., 78s.}$$

Since this evaporation of the said liquor could be carried out by solid fuel direct fired, the comparison should be made not on the price of steam, but on the cost of solid fuel, since the sulphate of ammonia plant operatives would attend to the whole process. Taking rough breeze at 5s. per ton, the calculation was $\frac{2692}{2240} = 1{\cdot}2$ tons at 5s. = 6s., against the 27s. 6d. The price of fuel could go up to £1 per ton before the costs by the two methods balanced.

Even if Mr. Williams' experiments were correct, and the carbon dioxide was chiefly responsible for corrosion, it would be admitted that hydrocyanic acid had a disastrous effect upon meters. Therefore it was better out than in. The method of taking it out was really subsidiary to the main idea of the paper. Possibly, Mr. Clayton's suggestion to take it out in the oxide rather than by washing would be much better.

Excessive water in the tar might or might not be due to the formation of a skin on the surface of the tar which contained the bulk of the free carbon which had been washed out. A much greater bulk of liquor was supplied to the mains than would be used in the ordinary course of events, and it was possible that in the washing of that liquor the skin forming on the top of the tar caused an excess of water. If the cyanogen washer was not used, a little ammonia would be necessary; it would pass forward to the boxes to keep them in a neutral state.

Mr. Vass had referred to the condenser falling instead of rising. That was the case with their plant; they altered their plant to suit their own conditions. Probably it would be difficult to upset the condenser arrangements which were already fixed; but if the ammonia was taken out in the hydraulic main, any condensate in the condensing plant would be acid. On the other hand, if a certain amount of ammonia was allowed to pass they must get the gas below the dew-point and allow the drainings to run back into the main; or else they would have a certain amount of ammoniacal liquor to deal with apart from the acid.

PETROLEUM WASH-OIL THICKENING IN THE SCRUBBING OF COKE-OVEN GAS.

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[From "Industrial and Engineering Chemistry."]

A high-boiling petroleum oil is used in the counter-current absorption of light oils from coke-oven gas in scrubbing towers. With continued use the wash oil increases in gravity from 0·834 to 0·90 and contains a suspension which, when settled out, does not materially affect the gravity of the oil. This process is called thickening. With thickening, a wash-oil reduces in absorption capacity, and the accumulation of the suspended material presents mechanical difficulties throughout the entire system. It is the object of this investigation to determine the primary cause of such thickening.

Cause of Thickening.

Kiemstedt[1] in 1925 summarized the suggested causes of thickening as follows:

(1) The oxygen content of the gases and its influence on the wash oil, especially on the phenols of the wash oils.
(2) The oxidation of hydrogen sulphide to sulphur and its asphalt-forming property.
(3) The capacity of oils for inorganic materials, especially compounds of iron and their catalytic influence on the process.
(4) The moisture content of the oils.
(5) Cracking.
(6) The prevailing pressure on the system.

In 1926 Hilgenstock[2] pointed out that "even at this late date no satisfactory explanation has been given for thickening."

Offe,[3] and Kattwinkel,[4] though disagreeing as to the mechanism of thickening, point to hydrogen sulphide as the primary cause. Offe states that the thickening is caused by the reaction of hydrogen sulphide with the unsaturated compounds present in the wash-oil, and their subsequent polymerization by heat with the regeneration of hydrogen sulphide. Kattwinkel, however, views the thickening as due to polymerization of the wash-oil by sulphuric and sulpho acids formed from the oxidation of the hydrogen sulphide present. Since hydrogen sulphide is present in the coke oven gas to the extent of 500 grains per 100 c.ft., such reasons seem quite logical. In addition, the wash oil on thickening increases in sulphur content from 0·182 to 0·967 p.ct.

All attempts to thicken a new wash-oil with hydrogen sulphide were unsuccessful. No thickening resulted when hydrogen sulphide was bubbled through cold or hot oil for three weeks, or when a saturated solution of the gas in the oil was subjected to a treatment similar to that given in the stripping stills and heat exchangers. Even when steel wool was used as a catalyst, and the above processes duplicated, there was no thickening. In some cases, however, there was a slight and insignificant increase in the sulphur content of the wash-oil after treatment.

Another suggested mechanism is that thickening may be the result of the sulphur as such being produced in the system by the reduction of hydrogen sulphide. It was found, however, that flowers of sulphur, though dissolving in hot oil, would precipitate on cooling and produce no thickening.

It has been suggested that thickening may be produced by cracking of the wash-oil in the stripping process. Experiments with new wash-oil, benzolized wash-oil, and wash-oil

saturated with hydrogen sulphide and flowers of sulphur, all produce no thickening when heated to a cracking temperature. In every case a black carbonaceous residue is precipitated and the light fractions formed volatilize, but the residual oil does not increase in gravity.

According to Bergbau and Lothringen[5] the thickening may be due to oxygen or carbon dioxide, or both, since their method of preventing thickening is the elimination of these constituents from the steam used in the stripping stills.

The influence of finely divided tarry matter on the thickening of wash-oils has been discussed by Gerhard,[6] Stumpf,[7] and Thau.[8] Brooks[9] points out that petroleum ether when added to certain oxidized hydrocarbons will cause a solid substance to precipitate. This method applied to spent wash-oil gave a light brown flocculent precipitate containing 78·30 p.ct. carbon, 6·28 p.ct. hydrogen, 9·25 p.ct. sulphur, and by difference 6·17 p.ct. oxygen. This indicates that a complex sulphur compound is formed in the wash-oil. The fact that it could not be produced by subjecting the oil to treatments with sulphur in various combinations led to the conclusion that it entered the system as such in the raw coke oven gas.

When spent wash-oil is allowed to settle at low temperatures a black plastic mass separates. This material has all the physical appearances of ordinary coal tar. In addition, at valves and other connections along the raw gas line where small leaks are possible, this same tarry material accumulates in stalactitic form. When this material is dissolved in benzene, added to wash-oil, and stripped of the benzene, a pronounced thickening in the oil is produced. Similarly, ordinary coal tar from tar sumps under the same conditions produces thickening in new wash-oil. The fact that this method had artificially produced thickening pointed to a tar in suspension in the raw gas as the primary cause of thickening.

When raw coke-oven gas was passed through an experimental absorption tower unit with glass-bead packing and new wash-oil, it was found that, after careful stripping, the oil had increased in specific gravity from 0·834 to 0·845. This increase in the specific gravity, and hence the relative thickening, appears small. However, a critical study points to their actual significance. At this rate, in a plant treating 50,000,000 c.ft. of gas a day with 60,000 gallons of wash-oil, the oil would become unfit for further use in the absorption system in 3·7 months. Executives at such a plant state that the life of an oil is about three months, and therefore the experimental thickening closely approximates operating plant results.

Quantity and Character of Suspended Material.

To determine the quantity and character of the suspended material in the gas, a quantitative experimental Cottrell precipitator similar to that described by Drinker and Thompson[10] was used. An applied voltage of 20,000 at 3 amperes was used in a tube 11 in. (28 cm.) long and 1 in. (2·5 cm.) inside diameter containing a removable celluloid foil upon which the material collected. A dark brown, sticky and tarry material with a rather characteristic obnoxious odour was formed on the foil. It was found that the gas contains 3·17 grammes of this material per 100 c.ft. (2·8 cub.m.). It was further found that no thickening was produced by a gas from which this material had been removed with a Cottrell precipitator.

Determinations on the amount of suspended material before and after passing through the experimental wash-oil absorption unit showed that approximately 90 p.ct. of this material remained in the gas, although thickening at plant rate was obtained. As an extreme test, a Cottrell precipitator showed the existence of this material in appreciable quantities in the gas delivered to the domestic consumer. The fact that the gas after light-oil stripping passes through a Koppers hydrogen sulphide absorption tower, two gasholders, and several miles of distributing mains points to the extreme fineness of the suspension.

The tarry material precipitated from the gas by the Cottrell was found to contain 12·50 p.ct. sulphur as compared with 4·54 p.ct. sulphur in the tarry material settling from spent wash-oil, and 0·97 p.ct. sulphur in ordinary coal tar. Thus the raw gas contains 0·0038 gramme of sulphur per c.ft. (0·028 cub.m.) exclusive of hydrogen sulphide. The increase in sulphur in the wash-oil on thickening, which has been attributed to sulphur in various forms, can be accounted for by the high sulphur content of the suspended material, which in itself produces thickening. It would appear that the tarry material in suspension contains a large proportion of a high sulphur constituent of coal tar. The analysis and physical properties of the material settling from spent wash-oil indicate that it contains a higher proportion of ordinary coal tar than the suspension. Considering, as before, an operating condition where 60,000 gallons of wash-oil are used in the treatment of 50,000,000 c.ft. of gas per day, the above sulphur figures have interesting application. Under these conditions where wash-oil on thickening increases in sulphur content from 0·182 p.ct. (sp. gr. 0·834) to 0·967 p.ct. (sp. gr. 0·900), the tarry material would account for the entire thickening and produce a spent wash oil in 8·6 days. However, it has been shown that only one-tenth of the tarry material is absorbed, so that complete thickening would be produced in 86 days. This length of time is again in close agreement with the commercial approximation of three months.

Conclusions.

The thickening in petroleum wash oil is shown to be the direct result of a tar or a tar constituent in a finely divided form suspended in the gas, which still persists in measurable quantities when the gas has reached the domestic consumer. It would appear, then, that thickening results from the direct baffling of this material in the absorption system, and from its solution in the light oils with subsequent precipitation on stripping. This is perhaps the reason for the opinion sometimes expressed that thickening is produced by polymerization in the stripping stills.

Experimental work using a Cottrell precipitator indicates that the removal of these high-sulphur tar constituents from the raw gas before entrance into the scrubber system will eliminate the thickening of wash oil in the countercurrent scrubbing of coke-oven gas. The elimination of the thickening constituents of raw gas on a commercial scale is now being investigated.

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[1] Kiemstedt, "Brennstoff-Chem.," **6**, 185, 201 (1925).
[2] Hilgenstock, *Ibid.*, **7**, 123 (1926).
[3] Offe, "Gas Wasserfach," **66**, 67 (1923); **68**, 136 (1925).
[4] Kattwinkel, *Ibid.*, **67**, 406, 474 (1924); **68**, 323 (1925); "Brennstoff-Chem.," **7**, 123 (1926).
[5] Bergbau and Lothringen, German Patent 432,378 (Jan. 3, 1924).
[6] Gerhard, "Gas Wasserfach," **66**, 189 (1923).
[7] Stumpf, *Ibid.*, **67**, 515 (1924).
[8] Thau, *Ibid.*, **67**, 163 (1924).
[9] Brooks, "Non-Benzenoid Hydrocarbons," p. 53 (1922).
[10] Drinker and Thomson, "J. Ind. Hyg.," **7**, 261 (1925).

Effect of Atmospheres on the Heat Treatment of Metals.—A paper on this subject by E. G. de Coriolis and R. J. Cowan, presented at a meeting of the Division of Gas and Fuel Chemistry of the American Chemical Society, deals with the effects of various atmospheres on metals during typical heating operations ranging from 350° to 2500° Fahr. These effects are shown to be essentially of a chemical nature. Methods for the application of heat are duly considered. The limitations of each is determined by the character of the atmosphere surrounding the work. This has emphasized the necessity for a controlled atmosphere. "The old designations of neutral, oxidizing, and reducing atmospheres have ceased to have a definite meaning in the light of more advanced knowledge." Some account is given of the research work of the American Gas Association in connection with forging. The matter of burning of steel is considered, and some new facts are given. A graph is presented showing the time-temperature relationship between carbon monoxide and scale formation at forging temperatures of steel. The problem of bright annealing is considered. This is effected by gases evolved when a metal is heated. The use of steam for the bright annealing of copper is discussed. The effects of lubricants found on metal surfaces present problems in relation to the specific atmospheres in bright annealing. Ways have been indicated for overcoming these problems.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

London's Clearer Atmosphere.

SIR,—We were interested in your note under the above heading in the last issue of the "JOURNAL," as the increasing purity of the air is of great importance to one of our departments, which is engaged in laying copper on roofs.

When a roof is covered with copper in a pure atmosphere it soon assumes a beautiful green "patina," which is characteristic of the metal and is so prominent a feature in many continental towns where the atmosphere is much purer than ours. For many years it was almost impossible to find these beautiful green roofs in London, but of late years there is a very great improvement in this respect, and green roofs are becoming increasingly common, in most cases starting in the suburbs such as Croydon, Highgate, Ilford, Richmond, &c.

Perhaps the most prominent example is the dome on the Imperial Institute, which was quite black until a few years ago; while there are many other domes and roofs in the process of turning green, which we do not think would have occurred unless the amount of soot and other impurities in the air had been so considerably reduced by the modern tendency to use gas fires, cookers, and water heating appliances. Let us hope that this tendency will continue, and that the atmosphere of London will be so greatly improved by the work of the gas industry that the green domes of London will be as prominent as those at Berlin, Vienna, Copenhagen, Munich, Dresden, &c.

S. EWART,
Director.

Ewart & Son, Ltd.,
346, 348, and 350, Euston Road,
London, N.W. 1,
Oct. 7, 1929.

REGISTER OF PATENTS.

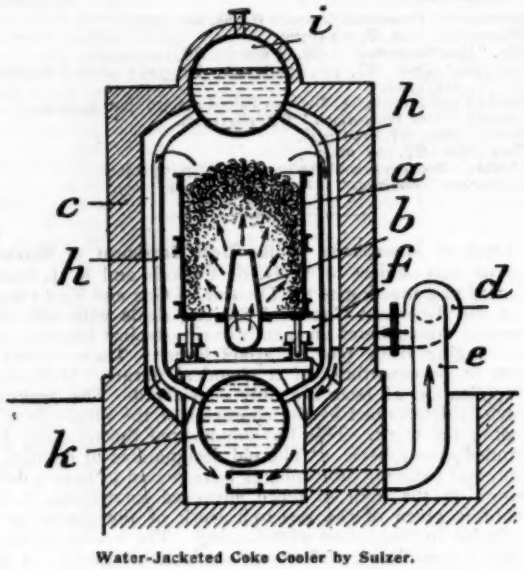
Dry Cooling of Coke.—No. 306,933.

SULZER FRÈRES STÉ. ANYME., of Winterthur.

No. 63; Jan. 1, 1929. Convention date, Feb. 29, 1928.

This invention relates to improvements in apparatus for the dry cooling of hot coke of the kind in which the coke is cooled by means of a current of gases passing through the container into which the coke is discharged. The object is to provide means whereby overheating, and consequent destruction of the container walls, will be obviated.

The container is surrounded by a cooled wall, preferably comprising tubes through which a cooling medium passes, so that, in addition to taking up the heat transferred to it by the cooling gases, the wall also absorbs the heat radiated by the coke, and thus increases the cooling effect on the walls of the container.



Water-Jacketed Coke Cooler by Sulzer.

In the construction illustrated in the drawing, the coke container *a* has a central projection *b* extending upwardly into the coke charge, and is adapted to be wheeled into a cooling chamber *c*. The arrangement is such that when the container is wheeled into position the lower end of the projection *b* automatically registers with the delivery pipe *f* of a blower *d* connected to the lower end of the chamber *c* by means of a suction pipe *e*.

In order to protect the walls of the container against high temperatures, the walls of the chamber *c* are lined with tubes *h*, having a cooling medium flowing through them, and surrounding the container *a* when the latter is in position within the chamber. The blower *d* drives a current of cooling gases in the direction of the arrows through the delivery pipe *f* into the coke charge and then round the outside of the tubes *h* and back to the blower through the suction pipe *e*.

At the top and bottom of the chamber *c* are disposed water drums *i* and *k* respectively, to which the tubes *h* are connected in such a way that they, together with the drums, form a water tube steam-generator having an intermediate free space or chamber between its water tubes for the reception of the coke container.

Clockwork Gas Controllers.—No. 318,320.

KING, W. E., and the GAS METER COMPANY, LTD., both of 238, Kingsland Road, E. 2.

No. 16,810; June 9, 1928.

The invention relates to gas controllers adapted to be operated by clockwork mechanism, and has for its object to provide improved and simplified construction.

The invention consists in the provision of readily detachable clockwork operating mechanism wherein a gas tap is operated in known manner by a clockwork operated see-saw lever which is rocked slowly against the tension of a spring to turn off the gas supply, but when tripped is rocked instantaneously to turn on the supply. The lever carries a pin which engages the slot in the disc so as to rock the latter in opposite directions to those performed by the lever.

The invention also consists in a gas controller device as set forth above in combination with a spring-operated plunger ball or disc valve; and also in a gas controller wherein the clockwork mechanism carries a plurality of horizontally disposed pins which form the sole means by which the mechanism is supported by the gas tap; at least one of the pins being locked by a set screw operable by the normal clockwork winding key, which screw, when released, enables the pins to be withdrawn axially from sockets in the casting.

Combination Valves for Gas Water-Heaters. No. 317,207.

WIATT, J. P., of Waterloo, New South Wales.

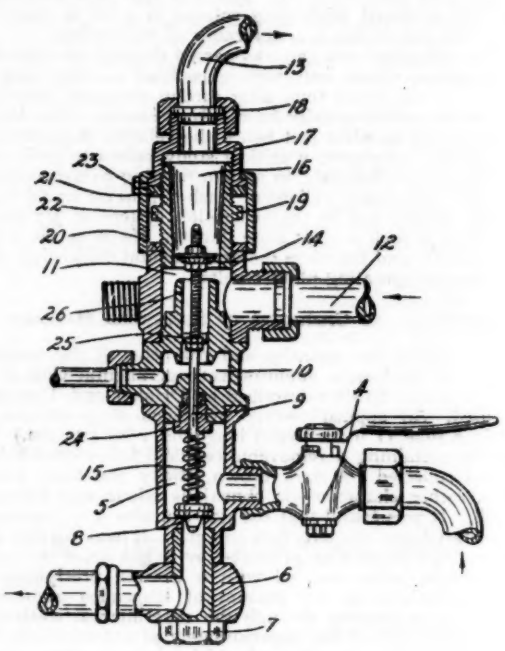
No. 21,415; July 24, 1928.

The accompanying diagram is a longitudinal section of the valve.

The gas regulating cock 4 is connected to a gas chamber 5 which leads to the gas burner of the heater or other device to which the appliance is fitted, by means of a union 6 and hollow screw 7. The passage of gas from the chamber 5 is controlled by a gas regulating valve 8 which is mounted on a stem 9 passing through an intermediate chamber 10 into a water receiving chamber 11 which is connected to the water service pipe 12 and leads to the water inlet pipe 13 of the heater.

On the top end of the valve stem 9 a disc or valve 14 is adjustably mounted. This disc is free to move in the water receiving chamber and is adapted to lift the gas regulating valve 8 from its seat when water is flowing through the water chamber into the heater. A spring 15 normally retains the valve 8 upon its seat.

The intermediate chamber 10 acts as a relief means should a leakage take place from the water chamber 11. An extension 26 of the intermediate chamber 10 is bored to receive a hat or cup leather packing 25 which is mounted upon the stem 9 of the gas regulating valve 8 and prevents the passage of water from the chamber 11 to the intermediate chamber 10.



Wiatt's Combination Valve.

In order progressively to increase or decrease the flow of water permitted to pass through the valve before the gas distributing valve 8 is opened, an internally tapered union 16 is screwed into the chamber 11 and also into a cap 17 which leads to the heater fittings 18 and pipe 13. The internally tapered union 16 is provided with hexagonal faces or with a knurled edge 19 and lock nuts 20, 21 for effecting external adjustment of the conditions controlling the valve 14. A cover 22 and grub screw 23 are provided to protect the union 16 and lock nuts 20, 21 from unauthorized interference. A stuffing box, packing, and gland 24 are provided to maintain a tight joint between the chamber 10 and the chamber 5.

The invention, states the patentee, forms a compact unit to which the gas and water supply services of the heater are attached in a convenient and accessible manner, while at the same time it affords means whereby it is impossible to open the gas supply until the water has been turned on, and, in addition, it ensures that the gas supply is cut off immediately upon the water supply being cut off.

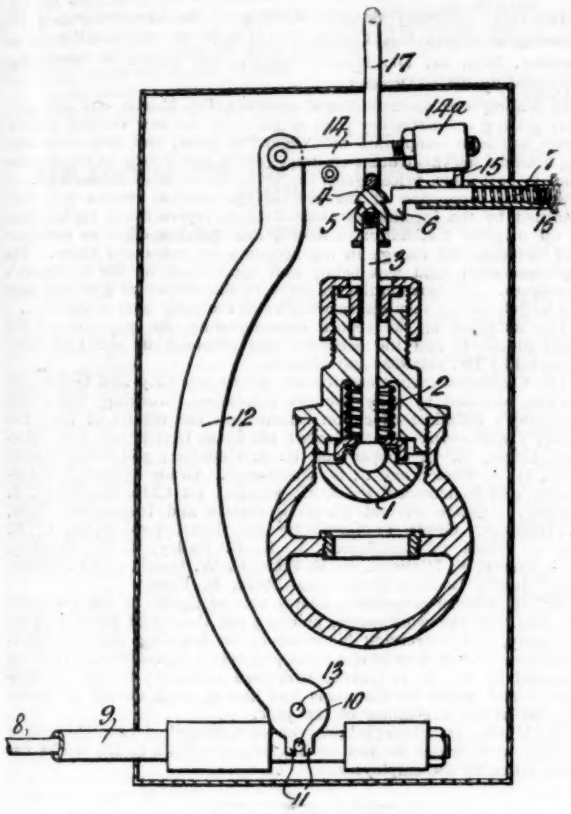
Thermostatic Control for Gas Burners. No. 318,305.

SOUTH METROPOLITAN GAS COMPANY, CHANDLER, D., and HOXLEY, H. W., all of 709, Old Kent Road, S.E. 15.

No. 13,297; May 5, 1928.

This invention relates to control devices for gas valves, and is particularly applicable for controlling the gas supplied to burners for ovens and furnaces. It concerns control devices comprising a tem-

perature sensitive device which is adapted on cooling to release a detent which normally maintains a valve in its open position, the movement of the sensitive device being multiplied by a lever system.



Thermostat by the South Metropolitan Gas Company.

The invention is illustrated in the accompanying drawing. 1 is a gas supply valve of the poppet type, having a spring 2 adapted to close it. The outer end of the valve stem 3 is provided with a head 4 undercut at 5 to receive a catch 6 urged into its locking position by a spring 7. The temperature sensitive device is comprised of a rod 8 of steel or other suitable material having a comparatively small coefficient of expansion. The rod is fixed at one end, and slidably mounted upon it is a tube 9 of brass or other suitable material having a comparatively high coefficient of expansion. The free end of the rod 8 is provided with an abutment against which one end of the tube 9 bears.

Mounted upon the tube 9, near to its other end, is a lug or projection 10 which engages a fork 11 on one end of a multiplying lever 12 pivotally mounted at 13. The other end of the lever 12 has pivoted thereto a trip lever 14 on which is adjustably mounted a weight 14a adapted to engage the face of a lug 15 on the catch 6. 16 is a screw by means of which the pressure exerted by the spring can be adjusted.

The valve stem 3 is provided with a handle or stirrup 17 by which the valve 1 can be raised into such position as to be held open by the catch 6.

In operation, the expansion of the tube 9 consequent upon rise in temperature when the oven or furnace is in operation causes the lever 12 to rock in an anti-clockwise direction, thus enabling the weight on the trip lever 14 to drop behind the lug 15. When the temperature drops to a given value the consequent contraction of the tube 9 causes the lever 12 to rock in a clockwise direction, the consequent movement of the trip lever 14 moving the catch 6 out of engagement with the valve stem 3 and thus releasing the valve. If it be desired to allow the valve to be released at different temperatures, this can be effected by adjusting the weight 14a on the lever 14. It will be seen that the valve 1 can be raised and held by the catch 6 even when the oven or furnace is cold.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official Journal" for Oct. 2.]

Nos. 28,699—29,478.

Anderson, W.—"Gas rings." No. 29,402.
Briggs, H. D.—"Refining crude benzole." No. 29,019.
Brook, I.—"Gas lighting appliances." No. 28,817.
Coupade, C. de.—"Gas and water valves for geysers, &c." No 28,862.
Kalabek, V.—"Gas turbine." No. 28,961.
Maclaurin, R.—"Treatment of ammonia liquor effluents." No. 28,899.
Maclaurin, R.—"Recovering acid ammonium carbonate from ammonia liquors." No. 28,900.
Palmer, H.—"Stop devices for gas mains." No. 28,917.
Shatwell, H. G.—See Briggs, H. D. No. 29,019.
Willey & Co., Ltd.—"Coin-freed mechanism of gas meters." No. 29,461.
Yorkshire Tar Distillers, Ltd.—See Briggs, H. D. No. 29,019.

MISCELLANEOUS NEWS.

GAS v. ELECTRICITY AT STAMFORD.

Public Lighting.

In the course of the past few days the Stamford Town Council have accepted the tender of the Stamford Gas Company for lighting the streets for one year at a cost of £739. In moving the recommendation of acceptance of this tender, the Town's Lighting Committee reported that both the Stamford Urban Electric Supply Company and the Stamford Gas Company had tendered for the street lighting contract, and that, though they moved that gas should again be utilized, they recommended that in the meantime the Council should consider the question of the lighting of the streets by electricity, and that negotiations to this end should be opened with the Electric Supply Company. The Gas Company's tender was £19 more than last year, but included the supply to several additional lamps, and, in some cases, an increased candle power.

It was stated that the Electricity Supply Company really offered favourable terms—but for two factors: They could not provide the light until Jan. 1, and that by far the larger portion of their contract price was swallowed up by providing a sinking fund for the purchase of the standards. The Company suggested that this particular charge should be spread over fourteen years, and the estimate they put forward contained the sum of £180 in respect to capital costs of lamps and equipment, this payment to continue for fourteen years. At the expiration of that period, the Council were told, "the whole of this charge would cease, and the electric lighting estimate would then compare more or less favourably with that of the Gas Company."

Opinions have been divided on the matter. It has, however, been pointed out that, on the score of economy, gas has the advantage of its main competitor, and, also, that there have been no complaints whatever as to the service from the Gas Company. In fact, if anything, the Company have been praised regarding its supply.

The Company have always borne the full cost of standards, lanterns, burners, &c., and with their tender offered discounts for three, five, or seven years' contracts, and under these terms were prepared to carry out improvements.

Now for the purpose of a change-over, the Town Council are debating whether they shall provide the capital expenditure of columns, &c., to enable the electric undertakers to give better terms. It is appreciated that the proposal is a vastly unfair one, and that it means an additional expense on the rates. Further, the Council have had the facts put before them that the Gas Company are large ratepayers, and that, equally, the revenue derived from town lighting reflects on a cheaper commodity for the ordinary consumer—and there are far more users of gas than electricity in the town.

PRIMITIVA HOLDINGS.

Good Response to Share Exchange Offer.

The Statutory Meeting of Primitiva Holdings, Ltd., was held on Oct. 1 at Winchester House, Old Broad Street, E.C.

Col. H. Le Roy-Lewis, C.B., C.M.G., D.S.O., who presided, said that the meeting was called to submit the statutory report in compliance with Section 65 of the Companies Act of 1908, but there was one matter of general interest to which he desired to refer. The Board were very pleased to be able to report that the response of the shareholders in the Primitiva Gas Company to exchange their shares for shares in Primitiva Holdings, Ltd., had been so nearly complete that 2,085,217 had been so exchanged. This figure represented 89·5 p.ct. of the shares of the Gas Company—excluding, of course, the 660,000 shares of the Gas Company recently issued to the Spanish American Electricity Company (Cia. Hispano-Americana de Electricidad).

The number of shares in the Gas Company which had not been exchanged amounted to only 254,247, and the Board urged the holders of these shares, in their own interests, to make the exchange, as the market in so small a number of gas shares was likely to be restricted. To facilitate the exchange of the remaining shares, the Board had arranged to keep the list of the Holdings Company open a short time longer; and any Gas Company shareholders desiring to exchange should communicate with the Secretary without delay.

The proceedings then terminated.

SINGAPORE GAS DEPARTMENT.

Large Increase in Business.

The coal used by the Singapore Gas Department during the past year has been chiefly Australian; but at the latter end of the year, owing to strikes in Australia, coal was purchased from England. The cost of coal delivered at the works was $17.23, against $16.81 for 1927. The demand for coke has been fairly steady throughout the year, and the revenue from this source was $127,782.69, against $128,053.87 for 1927. The average price per ton for 1928 was $31.88, against $32.53 for 1927. The revenue from tar was $44,291.77 for 1928, against $39,891.27 for 1927. The amount of gas manufactured was 348,466,000 c.ft., against 316,481,000 c.ft. made during 1927, an increase of 10·1 p.ct. Of the above quantity, 91,190,000 c.ft. was water gas, equal to 26·1 p.ct. of the make. The cost of manufacture for 1928, including interest, sinking fund, and renewals was $1.77, against $1.73 per 1000 c.ft. in 1927—an increase of $0.03.

The amount of gas used for public lighting totalled 116,318,880 c.ft., equal to 33·4 p.ct. of the output. During the year 163 new lamps were erected and 40 lamps cut off; 882 lamps were converted to higher candle-power lamps. The amount of gas sold to private consumers was 186,610,002 c.ft., against 167,230,056 c.ft. for 1927, an increase of 11·5 p.ct.; this quantity in 1928 is the largest amount sold for private consumption in the history of the undertaking.

The number of consumers showed a decrease during the year of 31; the average consumption per consumer is considerably higher than a few years ago. The unaccounted-for gas was equal to 10·4 p.ct. of the make, against 8·6 p.ct. for 1927. The net profit for 1927 was $17,208.57. The gross profit made by the Department, allowing for public lighting at cost, was $248,183.54, and, after deducting interest on loan, sinking fund, and renewal charges, there was a net profit of $137,095.83.

BRITISH TAR FOR ROADS.

"A Thoroughly Satisfactory Road Dressing."

The following letter by Mr. W. A. Wayland, of the Royal Empire Society, appeared in a recent issue of the "Yorkshire Post" on the subject of British tar for roads:

It is a matter of grave concern to me and the organization I represent to learn that part of the expenditure of public money on the reconstruction and maintenance of our roads is devoted to the purchase of foreign material when excellent British material is available.

Many of our County Councils are now using foreign bitumen as the surface dressing on our roads, where formerly they used British tar. For this my inquiries in various quarters have produced no satisfactory explanation. The experts seem to be agreed that the perfect road surface has still to be discovered, and on purely technical grounds the Ministry of Transport simply insists that either tar or bitumen may be used, so long as the material complies with the official standard specifications.

From the point of view of the road engineer, therefore, it would appear that British tar of the standard quality is a thoroughly satisfactory road dressing, carrying the approval of the Ministry of Transport, and, this being so, its use in preference to bitumen seems to be called for on the wider ground of helping our home industries and providing employment for our own people.

SIR JOHN CASS TECHNICAL INSTITUTE.

Inauguration of the Work of the 1929-30 Session.

Before dealing with the programme of work for the present session, the Chairman of the Governing Body (the Rev. J. F. Marr, M.A.) reviewed the work of the past academic year, and stated that the provision of grouped courses of instruction had been greatly appreciated by those engaged in technical branches of industry, and, further, that insistence on a good knowledge of fundamental science as an antecedent to specialized or vocational training had led to the most satisfactory results. An extension of advanced and post-graduate work had also been made, with considerable success.

A total of 29 students were successful at the London University post-Matriculation Examinations, and of this number, one obtained the degree of Ph.D., one the M.Sc. degree, 12 B.Sc. degrees with Honours, 1 B.Sc.Eng. (Metallurgy) degree with Honours, 7 Pass degrees in Science, and 2 Pass degrees in Engineering (Metallurgy). During the past eleven years 127 students had graduated from the Institute, and, in addition, 27 post-graduate degrees, including one D.Sc. degree, had been obtained.

The programme of work for the present session includes a considerable extension of the course of lectures on "Coal Carbonization," and the addition of two courses of lectures on "The Application of X-ray Analysis to Chemical Problems" and "Micro-Chemical Analysis" respectively.

Lord Riddell, who delivered the Inaugural Address, emphasized the necessity of co-operation between good salesmanship and good production; and in this connection it may be pointed out that excellent facilities are provided at the Cass Institute for those engaged in the distributive branches of industry to acquire a comprehensive knowledge of the science and technology underlying their vocational work.

LEAMINGTON PRIORS GAS COMPANY.

The 129th Ordinary General Meeting.

The 129th Ordinary General Meeting of the Shareholders of the Leamington Priors Gas Company was held at the Gas-Works on Tuesday, Sept. 24, Dr. Harold Mason, the Chairman, presiding, supported by his co-Directors.

In dealing with the report and accounts, Dr. Mason said that they were getting a satisfactory yield of gas from the new vertical retorts. There had been complaints with regard to noise, and they were hoping to overcome this trouble entirely. There was a drop in the revenue from bye-products, prices generally being lower than a year ago. A substantial proportion of the cost of the vertical retorts had been admitted by the income-tax authorities as representing replacement of the original installation, and this had had the effect of considerably reducing the charge in the accounts for rates and taxes. The superannuation fund was being well appreciated by the Company's employees. The substantial increase in the output of gas had been due largely to the very severe weather in the early part of the year.

The adoption of the report recommending the payment of the usual dividends and the accounts was proposed by the Chairman, seconded by Dr. Haynes, and carried.

The Chairman then presented the prizes and City and Guilds certificates obtained by their younger employees, working under the Company's technical education scheme, on the results of their last winter's work—viz.,—Final Grade: 1st Class Certificates and Directors' Prizes, A. C. Cooper and R. J. Gadsden; 2nd Class Certificates, H. A. Norton and F. G. Weatherall. Grade 2: 1st Class Certificate and Instructors' Prize, H. Clarke; 1st Class Certificate, E. Hawtin. Grade 2: 2nd Class Certificate and Instructors' Prize, B. Jennings. Grade 1: Certificate and Instructors' Prize, C. H. Smith. Grade 1: Certificates, T. E. B. Bailey, T. Y. Doughty, E. A. Heath, F. Hickson, W. F. Pope, E. W. Smith, and G. Wilderspin. Junior Course: Instructors' Prize, B. Pope.

Mr. H. Rayner proposed a hearty vote of thanks to the Directors, the staff, and the workpeople, pointing out the sound position of the Company, and expressing his pleasure on learning that the superannuation scheme was in operation and being appreciated. This was seconded by Mr. S. J. Green, who bore testimony to the disadvantages under which the Company had had to work during the severe weather at the beginning of the year.

Dr. Mason, in acknowledging the vote, remarked upon the interest in their work which he saw on his frequent visits to the works was being taken by the employees.

LARGELY INCREASED OUTPUT AT DUBLIN.

Excellent Hire-Purchase Results.

Sales of gas in Dublin went up by 400,000 therms, or 85 million c.ft., while the number of consumers increased by nearly 3000 from January to June.

This statement was made by Mr. Francis J. Dickens, J.P. (Chairman), at the half-yearly meeting of the Alliance and Dublin Consumers' Gas Company, which was held at the Company's offices in Dublin on Sept. 25. The Chairman was hopeful that the announcement of a reduction in price was not far distant. A dividend of £7 12s. 6d. p.ct. per annum, *less* income-tax, was declared.

Moving the adoption of the report, and statement of accounts for the half-year ended June 30, the Chairman, in the course of his address, said: Six months ago we found cause for congratulation in the fact that our sales recorded an increase of 4 p.ct., and at that time one of our stockholders expressed the opinion (which was not, of course, shared by the Directors) that we had probably reached the peak. How far this was from being the case will be apparent when I say that our sales for the half-year are greater by more than 8 p.ct. than our sales for the June half-year of 1928, the amount of the increase being, roughly, more than 400,000 therms, or 85 million c.ft. The extent of this increase is most gratifying, particularly when we consider that it is only one of the constant series of increases which we have enjoyed for a number of years.

Hire-Purchase System.

The most gratifying feature is, however, that the average consumption per consumer has increased. This is particularly noticeable in the case of our ordinary meter department, wherein have occurred many noteworthy instances in the use of additional gas apparatus. Our prepayment meter department displays the same tendency, if to a less marked extent per consumer. The increase in this case has not been unexpected, because many of our prepayment consumers have taken advantage of our hire-purchase system for the installation of gas fires and other appliances, the use of which must necessarily raise the average consumption. We sold outright and on hire purchase or on hire no fewer than 3880 gas cookers, 1312 gas fires and radiators, 201 water heating appliances, and a considerable number of ovens, hotplates, grillers, and other apparatus.

Taking the capital account, our expenditure under this heading is not, in view of the developments to which I have referred, excessive at £12,600 odd, while the amount written off for depreciation, sales, &c., amounts to nearly £11,900, leaving the net increase at roughly £700. On the income side of the revenue account, sales of gas show the splendid net increase of £18,000, while rental of meters and stoves is greater by £4500.

Summarizing the financial position, therefore, our receipts from all sources are higher by £14,300, and our expenditure by £9900, so that the profit which we carry into net revenue is larger by £4400 at £77,600. Deducting from this the amount of the debenture interest, interest on temporary loans, and income-tax, and adding the balance from last account, we have available the sum of £83,222,

of which the dividend recommended will absorb £59,165, leaving £24,057 to be carried to our next account.

On the motion of the CHAIRMAN, seconded by Mr. W. NEWBIGGING, the report and statement of accounts were unanimously adopted.

A dividend of £7 12s. 6d. p.ct. per annum, *less* income-tax, on the consolidated ordinary stock was declared, on the motion of the CHAIRMAN, seconded by Mr. MAHER.

A vote of thanks to the Chairman and Directors was unanimously passed, on the motion of Mr. WEST, seconded by Mr. J. J. MOORE.

NEW COLLIER FOR THE GAS LIGHT AND COKE COMPANY.

Launching Ceremony at Hebburn.

Messrs. Hawthorn, Leslie, & Co., Ltd., of Hebburn-on-Tyne, launched on Friday last the single-screw self-trimming collier "Suntrap," which they are building to the order of the Gas Light and Coke Company. The vessel is 226 ft. in length and constructed to the highest class Lloyds. She will be fitted with triple expansion engines supplied by Messrs. George Clark, Ltd., of Sunderland. The vessel was christened by Mrs. R. W. Foot, wife of the General Manager of the owning Company.

Interesting comparisons between the old and modern methods of coal transport were made at the launch by Mr. H. B. Robin Rowell, a Director of Messrs. Hawthorn, Leslie, & Co., Ltd., Mr. R. W. Foot, and Mr. R. Stephenson Clarke, who represented Messrs. Stephenson Clarke and Associated Companies, Ltd., agents for the owners, and who have superintended the construction of the vessel.

Mr. ROWELL said that in the old days the wooden ships that carried the coal from the Tyne to London took a week in fair weather, whereas now colliers reached their destination in about five or six tides, and had their cargoes literally torn from them by grabs. The huge ballast hills on Tyneside, many of which contained hundreds of thousands of tons, were composed of Kent gravel which the old ships had to utilize as ballast in their voyages to the Tyne. A modern collier did fifty or sixty trips a year, as compared with sometimes less than a dozen trips by the old vessels.

Mr. R. W. FOOT said that coal was really stored up sunshine, and his Company re-converted it into sunshine. The "Suntrap," which was appropriately named, would carry about 80,000 tons of coal a year to London, which would be converted into millions of cubic feet of gas, which would make the Metropolis less murky and improve the conditions of those who lived there.

OVERSEAS OPPORTUNITIES.

[Extracted from the Board of Trade Journal.]

Ceylon.

Refrigerators and Steel Safes.—A firm of manufacturers' agents in Colombo wish to secure the representation of British manufacturers of refrigerators for domestic purposes and steel safes for Ceylon. **(Ref. No. 353.)**

GAS ACTS (1920 AND 1929) ORDERS.

SECTION 6.

Bolsover Gas Light and Coke Company, Ltd.

The Company shall, from April 1, 1930, charge according to the number of B.Th.U. supplied, and shall on or before Jan. 1 give notice of the calorific value of the gas they intend to supply.

Bury Corporation.

The Corporation shall, from April 1, 1930, charge according to the number of B.Th.U. supplied, and shall on or before Jan. 1 give notice of the calorific value of the gas they intend to supply.

Campbeltown Corporation.

The Corporation shall, from March 31, 1930, charge according to the number of B.Th.U. supplied, and shall on or before Dec. 31 give notice of the calorific value of the gas they intend to supply.

Elgin Corporation.

The Corporation shall, from April 1, 1930, charge according to the number of B.Th.U. supplied, and shall on or before Jan. 1 give notice of the calorific value of the gas they intend to supply.

Marsden Urban District Council.

The Council shall, from April 1, 1930, charge according to the number of B.Th.U. supplied, and shall on or before Jan. 1 give notice of the calorific value of the gas they intend to supply.

Newcastle-under-Lyme Corporation.

The Corporation shall, from April 1, 1930, charge according to the number of B.Th.U. supplied, and shall on or before Jan. 1 give notice of the calorific value of the gas they intend to supply.

Penrith Urban District Council.

The Council shall, from Jan. 1, 1930, charge according to the number of B.Th.U. supplied, and shall on or before Oct. 1 give notice of the calorific value of the gas they intend to supply.

DECLARATIONS OF CALORIFIC VALUE.

Holmfirth Gas Light Company.—450 B.Th.U. (Jan. 1, 1930).
Keighley Corporation.—500 B.Th.U. (April 1, 1930).
Longridge Gas Company.—460 B.Th.U. (Jan. 1, 1930).
Penrith Urban District Council.—500 B.Th.U. (Jan. 1, 1930).
Spennymoor and Tudhoe Company.—500 B.Th.U. (Jan. 1, 1930).

TRADE NOTES.

Belfast Gas-Works Improvements.

The Belfast Corporation have accepted the tender of West's Gas Improvement Company, Ltd., of Manchester, for the reconstruction of "C" bench of vertical retorts at the gas-works, and the supply of waste-heat boilers and necessary electrical generating plant.

Davis "Injector-Ventilating" Gas Fires.

The new Davis catalogue of injector-ventilating gas fires has just have published, and, as usual, contains a list of attractive types of gas fires for the coming season. The latest colour finishes are well to the fore, illustrated in the actual colours, and they should prove very popular for various furnishing schemes. The system of the "injector-ventilator" is fully explained, together with the "Nautilus" flue arrangement, while there is also a section on useful accessories for Davis gas fires.

Gas Lighting Glassware.

Lighting Trades, Ltd., with which is associated the Welsbach Light Company, Ltd., of 30-31, Farringdon Street, E.C.4, have published a new gas lighting glassware catalogue. This is an interesting and attractive production containing details of all shapes and forms of glass, bead, silk, and parchment fittings for gas burners, as produced by the firm. There is an enormous range of beautifully coloured and designed globes, suitable for any kind of furnishing or colour scheme, while lines in chimneys, reflectors, and mantle and ceiling protectors are also included

Weldless Steel Mains and Lapwelded Steel Pipes.

The British Mannesmann Tube Company, Ltd., of 67, Queen Victoria Street, E.C. 4, have published two new catalogues on the subjects of weldless steel mains and lapwelded steel pipes. One of the outstanding qualities that is claimed for lapwelded steel mains is their great strength and ability to resist shock. The pipes are made in all diameters from 14 in. up to 72 in. with adequate shell thickness to ensure a maximum degree of durability, and in lengths up to 25 ft. If specially long lengths are required, two or more pipes are joined together by means of circumferential welding.

Electric Arc Welding.

An interesting operators' handbook on electric arc welding has just been published by Alloy Welding Processes, Ltd., of Ferry Lane, Walthamstow, E. 17. This handbook has been compiled for the benefit of the progressive operator who is desirous of becoming better acquainted with the latest developments in metallic arc welding. Highly technical phrases have been omitted, and only ordinary terms are employed. A careful perusal of the book should enable those who use their discrimination to secure better results, and thereby not only substantiate the claims made for electric arc welding, but also justify extended application of the process.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *Oct.* 7.

There are practically no changes in the prices of tar products to report.

Pitch is about 47s. 6d. per ton f.o.b.

Creosote for export is 6¾d. per gallon f.o.b.

Pure toluole is 2s. 3d. to 2s. 4d. per gallon; solvent naphtha, 95/160, about 1s. 5d. per gallon; pure benzole, about 1s. 11d. per gallon; and pyridine bases, 3s. 9d. to 4s. per gallon.

Tar Products in the Provinces.

Oct. 7.

There is practically no alteration in the markets for tar products.

Pitch prices have been well maintained, and business continues to be done at 47s. 6d. f.o.b.

In creosote, there is no alteration in the market.

Crude carbolic is still very firm, and 2s. 6½d. is reported to have been paid for January/June next year.

The crystals market remains firm, with comparatively high prices asked for prompt delivery.

There are no alterations in water-white products.

The average prices of gas-works products during the week were: Gas-works tar, 25s. to 30s. Pitch—East Coast, 47s. 6d. f.o.b. West Coast—(f.a.s.) Manchester, 42s. to 42s. 6d.; Liverpool, 45s. 6d. to 46s. 6d.; Clyde, 45s. 6d. to 46s. 6d. Toluole, naked, North, 1s. 7¼d. to 1s. 8¼d. Coal-tar crude naphtha, in bulk, North, 9d. to 10d. Solvent naphtha, naked, North, 1s. 3d. to 1s. 3½d. Heavy naphtha, North, 1s. to 1s. 0¼d. Creosote, in bulk, North, liquid and salty, 3¼d. to 3½d.; low gravity, 2d. to 2¼d.; Scotland, 3¼d. to 3½d. Heavy oils, in bulk, North, 5¼d. to 6d. Carbolic acid, 60's, 2s. 5d. to 2s. 6d. prompt. Naphthalene, £12 to £14. Salts, £5 to £5 10s., bags included. Anthracene, "A" quality, 2½d. per minimum 40 p.ct., purely nominal; "B" quality, unsaleable.

Benzole Prices.

The following are considered to be the market prices to-day:

	s. d.		s. d.	
Crude benzole	0 10	to	0 11	per gallon at works
Motor ,,	1 5	,,	1 6	,, ,, ,,
90 p.ct. ,,	1 7	,,	1 8	,, ,, ,,
Pure ,,	1 10	,,	1 11	,, ,, ,,

The single-screw self-trimming collier "William Cash," 234 ft. in length, built by Messrs. Hawthorn, Leslie, & Co., Ltd., to the order of Messrs. Stephenson Clarke and Associated Companies, Ltd., which is intended to carry coal for the Bournemouth Gas Company, has passed through successful sea trials. [See "JOURNAL" for Sept. 11, p. 562.]

Coke Oven Gas for Bradford.—The Bradford Corporation Gas Committee, on Oct. 3, approved a draft agreement prepared by the City Gas Engineer and General Manager (Mr. E. J. Sutcliffe), under which Bradford will purchase coke oven gas from the Low Moor Coke Oven Company.

Cheaper Gas at Hastings.—The Hastings and St. Leonards Gas Company announce that as from the current meter readings (Michaelmas) the flat rate price of gas will be reduced one halfpenny per therm—to 10d. per therm, equal to 3s. 10d. per 1000 c.ft., of 460 B.Th.U. gas. A corresponding adjustment will be made in the extended area and to prepayment consumers.

Dewsbury Trades and Fashions Exhibition.—The Dewsbury Corporation Gas Department had four stands at a Trades and Fashions Exhibition, promoted and arranged by the Dewsbury Chamber of Trade, at the Town Hall. Fires, cookers—including the automatic gas cooker—gas washing machines, the gas-operated refrigerator, gas irons, and the latest in lighting made an attractive display.

Popular Cooking Demonstrations at Oldham.—During the past few weeks the Oldham Gas Department have had a series of five cookery lectures and demonstrations in the out-townships of their area. These have proved very popular, and have been visited by more than 7000 people. An interesting feature of the demonstrations was a competition for cake-making, and no fewer than 150 cakes were entered. The lady in charge of the demonstrations was Mrs. M. A. Feilden, M.C.A., U.F.C.A.

Coal of Uniform Quality.—In an address in the Manchester Coal Exchange, Mr. Edgar C. Evans, Fuel Officer to the National Federation of Iron and Steel Manufacturers, said that one of the most important tendencies in modern fuel utilization was the tendency toward uniformity. The day was coming nearer and nearer when coal would no longer be purchased by brand, but by its analysis—by its properties, its size, and so on. Already there was a tendency in that direction. A Manchester man was the first in Britain to introduce the principle of the sale and purchase of coal by analysis. Mr. Evans showed how uniformity of fuel in industry would materially reduce costs.

Birmingham Gas Department's Sports Ground.—Mr. H. A. Butler, of the brewery firm of Messrs. Mitchells & Butlers, unveiled last Saturday week a clock which he recently presented to the City of Birmingham Gas Department Social and Recreation Society, at their sports ground, Hollyfields, Erdington. The gift was in commemoration of the holding of the Midland Counties Amateur Athletic Association sports there in June this year. The ceremony was attended by Alderman J. H. Lloyd, Chairman of the Birmingham Gas Committee, and several members of that Committee. Fixed on the apex of the sports pavilion, the clock is a most useful addition to the grounds.

The Year's Results at Oldbury.—Presenting the report of the Gas Committee to a meeting of the Oldbury Urban Council, Councillor Wilson drew attention to the final accounts for the year ended March 31, 1929, which showed that the total income for the year was £49,591, as compared with £52,855, last year, a decrease of £3253; the gross profit amounted to £8092, against £9683 last year, a decrease of £1591. After payment of interest and sinking fund charges, &c., there was a net profit of £10 16s. 8d., as compared with £2943 last year. He remarked that so small a profit seemed to be sailing rather near the wind, but the benefit had been handed on to the consumers in the shape of reductions in the price of gas during the year. The report was adopted.

Ellesmere Port and Whitby Gas Department.—The report of the Gas Manager for the year ended March 31 shows that the output of gas by the Ellesmere Port and Whitby Gas Department for the year amounted to 125,218,735 c.ft., as against 116,822,820 c.ft. for the previous year—an increase of 7·19 p.ct. A total of 7308 tons of coal was used, showing an average yield per ton of 18,532 c.ft. The business done through the showrooms has improved, and the cash sales were to the value of £500, and the hire-purchase goods to the value of £1400. It is noteworthy that for the first time in the history of the gas undertaking, the Department has, in each of two successive years, been able to make a net profit—viz., in 1927-28, £1349; and in 1928-29, £1177. At the beginning of the year a reduction of 5 p.ct. was made in the price of gas, the net amount received for the sales of gas being £29,423.

Colonial Gas Association Report.—After providing £8382 for depreciation, the balance at credit of revenue account is £103,866. Adding the balance brought forward from last year—viz., £14,093—and deducting bank, loan, and debenture interest, and after payment of interim dividend of 4 p.ct. and 4½ p.ct. paid in April last on the preference and ordinary shares respectively, the amount at credit of the net revenue account is £62,896. The Directors recommend as follows: (*a*) That a dividend at the rate of 8 p.ct. per annum (*less* interim dividend of 4 p.ct. for the half-year ended Dec. 31, 1928) be paid on the preference shares; (*b*) that a dividend at the rate of 9 p.ct. per annum (*less* interim dividend of 4½ p.ct. for the half-year ended Dec. 31, 1928) be paid on the ordinary shares; (*c*) that £1000 be added to reserve fund; (*d*) that £9500 be set aside for Australian income-tax on profits earned to June 30, 1929; and (*e*) that the balance (approximately £14,116) be carried forward to the next account. The Directors' report states that the sales of gas show an increase of 4·8 p.ct. over the sales for the preceding year, and the sales of gas for the subsidiary companies an increase of 6·1 p.ct. Since the report, amalgamations have taken place with the Rockhampton Gas and Coke Company, Ltd., and the Wynnum and Manly Gas and Lighting Company, Ltd., both of Queensland, such amalgamations being effected by exchanges of shares. At the last annual meeting the capital of the Company was increased by the creation of 25,000 additional 8 p.ct. preference shares of £1 each and 50,000 additional ordinary shares of £1 each.

New German Coke Plant.—In view of the increasing demand for coke, the United Steel Works will erect 143 new ovens with a yearly production capacity of 930,000 tons.

Price Reduction at Birstall.—The Birstall Urban District Council have approved a Gas Committee recommendation to reduce the charge for gas, as from the September meter readings, by 5d. per 1000 c.ft. to all consumers.

Schemes for Unemployment at Shipley.—Schemes of the Shipley Urban District Council, designed to alleviate unemployment and dependent on grant from the Unemployment Grants Committee, include the provision of various new trunk gas mains, at an estimated cost of £3800, and the re-sheeting of gasholders at a cost of £3000.

Exhibition of Gas Appliances at Halifax.—The Halifax Corporation Gas Department are holding an exhibition of gas appliances—particularly for domestic uses—at Woodside Hall, Haley Hill, from Oct. 7 to 12, inclusive. There is a formal opening ceremony each day. Miss Edith Sanderson is giving cookery demonstrations twice daily.

Progress of the Bradford Travelling Showroom.—The travelling showroom of the Bradford Corporation Gas Department, which has previously been described and illustrated in the "Journal," was reported to the Committee last week to have been visited by 3524 people during the 67 days it had been open, and the cash value of business done up to date through the showroom was £1399.

Gas Exhibition at Yeadon.—The Yeadon and Guiseley Gas Company have organized a Health, Comfort, and Smoke Abatement Exhibition, at the Yeadon Town Hall, from Oct. 7 to 12, inclusive, featuring the services and advantages of the use of gas and coke in the home. "Use Gas and Let in the Sunshine" is the motto of the exhibition. Cookery demonstrations are being given twice daily.

Cirencester Gas Company Report.—The revenue account shows a profit on the year's working of £3117. Interest on the debentures and the interim dividend at the statutory rate have been paid, and the Directors recommend a final dividend at the rate of 12, 6, and £8 8s. p.ct. on the several classes of shares respectively, making 11, 5½, and £7 14s. p.ct. for the year. Gas sales continue to show an increase. The price of gas has been further reduced by 3d. per 1000 c.ft., and now stands at 12·66d. per therm, or 4s. 9d. per 1000 c.ft.

Gas to the Aid of Justice.—On the night of Oct. 5, the electricity supply at Leatherhead failed, and considerable inconvenience was caused in the town. Tradesmen, in the busiest hours of the evening, had to send out for candles. Shops that sold candles ran out of their supplies after a brief but sharp siege. But one spot in the darkened district continued to blaze with light. This was the police station, where, in the undimmed radiance of gas lights, the officers of the law carried on their duties in happy ignorance of the great gloom outside.

Piping Progress in Birmingham.—A spirited demand has been made under the scheme of the Birmingham Gas Department for the piping of houses in courts and terraces throughout the city, whereby the cost of the work is paid for by the tenant through the automatic meter. At the July meeting of the Council, the Gas Committee reported that orders had been received for such supplies during the twelve weeks ended May 31, 1929, in respect of 1961 houses. At Sept. 30, this number had been increased to over 8000, and, in addition, many thousands of requests for supplies are in course of negotiation. It is estimated that orders will be received during the present twelve months in respect of at least 12,000 houses. All the available labour, both of the Department and the members of the Birmingham Master Gasfitters' Association, is being employed, and the mains and service gangs have been supplemented to the utmost extent.

Swinton Lighting.—The Swinton Urban Council have decided to use electricity entirely for their street lighting, in spite of the fact that they are partners in a joint municipal gas undertaking with the Mexborough Urban Council. The installation was offered by the Rotherham Corporation. Mr. M. Creighton said electric lighting meant a saving of £32 per annum, and in addition they got the electric lamps installed free, while the installation of the gas lamps would require the immediate expenditure by the Council of £120. Mr. W. Chappell, one of the Council's representatives on the Swinton and Mexborough Gas Board, opposed the scheme, and moved that gas lighting be installed. He said it was agreed that the gas lamps gave the better light, but the Committee came to their decision purely on the financial considerations. He urged that the whole town was crying out for an improvement in their bad street lighting, and that that was the main purpose, not the saving of an amount that meant a seventh of a penny rate. Mr. Chappell had only one supporter, and the electrical installation was decided on.

Competition with Private Enterprise at Blackpool.—Objection to a Gas Committee scheme to borrow £10,000 for the purchase of gas appliances and to appoint a gas appliance salesman was made by Councillor W. Cooper at Blackpool Town Council, on Oct. 2. He expressed the hope that the Council would not enter into competition with private enterprise. Councillor Tatham also objected to public authorities opposing private enterprise. "We are going to be traders in gas appliances which, in my view, is entirely wrong," he said. He moved the whole question back. Councillor Tomlinson, the Chairman of the Gas Committee, said Blackpool was the only town in England where the Corporation did not participate in a scheme of that kind. Councillor Newsome asked whether the Council represented ratepayers, plumbers, or tradespeople. "We are sent by the ratepayer, and there is a great demand for gas stoves and gas fires. Some people have not the money to buy them outright. Plumbers and representatives of the Chamber of Trade have agreed to accept the scheme," he said. Councillor Bailey said it was an agreed scheme between Council, plumbers, and Chamber of Trade. The minutes were approved.

STOCK AND SHARE LIST.

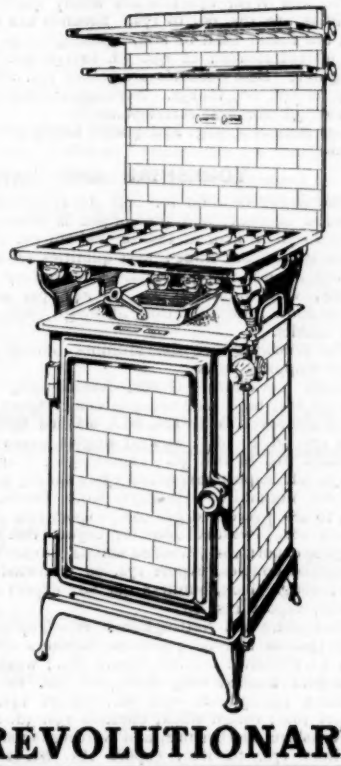
[For Stock Market Report, see earlier pages.]

Issue.	Share.	When ex-Dividend.	Dividends, Prev. Hf. Yr.	Dividends, Last Hf. Yr.	NAME.	Quotations, Oct. 4	Rise or Fall on Week.	Transactions Lowest and Highest Prices.
£			% p.a.	% p.a.				
171,978	Stk.	Aug 15	5	5	Aldershot 5 p.c. max. C.	70—75	..	..
412,992	,,		4	4	Do. 4 p.c. Pref.	73—76	..	..
1,551,868	,,	Sept. 26	7½	7½	Alliance & Dublin Ord.	95—98*	+1	94½—97
374,000	,,	July 11	4	4	Do. 4 p.c. Deb.	62—65	..	..
522,655	,,	Aug. 29	7	7	Barnet Ord. 7 p.c.	112—115	..	..
300,000	1	May 9	1/4½	1/4½	Bombay, Ltd.	½—⅝	..	..
172,500	10	Aug. 29	8½	9	Bournemouth 5 p.c.	12½—13½	..	..
500,050	10	,,	7	7	Do. B 7 p.c.	12½—12¾	..	12½—12 9/16
499,160	10	,,	6	6	Do. Pref. 6 p.c.	10½—11	..	..
50,000	Stk.	July 11	3	3	Do. 3 p.c. Deb.	54—57	..	..
162,025	,,	,,	4	4	Do. 4 p.c. Deb.	72—75	..	..
357,900	,,	Aug. 29	7½	7½	Brighton & Hove 6 p.c. Con.	113—116	..	..
371,880	,,	,,	6¾	6¾	Do. 5 p.c. Con.	100—103	..	..
1,387,500	,,	July 25	5	5	Bristol 5 p.c. max.	89—90a	..	..
885,000	,,	Sept. 12	7½	7	British Ord.	115—118	..	115½—116
100,000	,,	June 27	7	7	Do. 7 p.c. Pref.	112—117	..	..
190,000	,,	,,	4	4	Do. 4 p.c. Red. Deb.	71—74	..	72½
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb.	94—97	..	96½
100,000	10	May 30	6	8	Cape Town, Ltd.	9—10	..	..
100,000	10	Apl. 24	4½	4½	Do. 4½ p.c. Pref.	6½—7½	..	..
150,000	Stk.	June 27	4½	4½	Do. 4½ p.c. Deb.	71—75	..	..
696,860	,,	July 25	6	6	Cardiff Con. Ord.	98—101	..	..
197,840	,,	June 27	7½	7½	Do. 7½ p.c. Red. Deb.	99—102	..	..
187,150	,,	Aug. 15	6½	5	Chester 5 p.c. Ord.	87—92b	..	..
98,936	1	May 9	1/2/-	1/2/-	Colombo Ltd. Ord.	35/—37/-	..	..
24,495	1	,,	1/4½	1/4½	Do. 7 p.c. Pref.	20/—22/-	..	..
375,402	1	Apl. 11	1/9½	1/9½	Colonial Gas Assn. Ld. Ord	24/6—25/6	..	25/9—26
187,848	1	,,	1/7½	1/7½	Do. 8 p.c. Pref	21/—23/-	..	23/1½
2,073,280	Stk.	July 25	7	5	Commercial Ord.	93—96	..	..
475,000	,,	June 13	3	3	Do 3 p.c. Deb.	56—59	..	..
187,560	,,	Aug. 15	7	7	Croydon sliding scale	105—110	..	105½
409,100	,,	,,	5	5	Do. max. div.	81—84	..	..
542,270	,,	Aug. 29	10	7	Derby Con.	118—121e	..	..
55,000	,,	June 27	4	4	Do. Deb.	68—71e	..	..
209,000	,,	Aug. 29	5	5	East Hull Ord. 5 p.c.	73—75	..	..
1,009,180	10	Sept 12	†7	†4	European, Ltd.	15—17	—½	14½—15½
19,703,480	Stk.	July 25	5½	5½	Gas Light & Coke 4 p.c. Ord.	17/9—18/3/	+·/3	17/6—18/3
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max.	61—63	..	61½—62
4,187,020	,,	,,	4	4	Do. 4 p.c. Con. Pref.	70—73	..	71—72½
5,603,620	,,	June 13	3	3	Do. 3 p.c. Con. Deb.	55—58	..	55½—58
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb.	97—100	..	98—99
82,500	,,	Aug 29	7	7	Hastings & St L. 5 p.c. Cons	98—103	..	..
259,740	,,	,,	5½	5½	Do. 3½ p.c. Conv.	77—82	..	..
70,000	10	Apl. 24	†10	†10	Hongkong & China, Ltd.	14—15	..	..
219,200	Stk.	Aug. 29	6	6½	Hornsey Con. 3½ p.c.	84—87	..	..
1,976,000	,,	May 30	10	20	Imperial Continental Cap.	380—400	—5	385—396
223,180	,,	Aug 15	3½	3½	Do. 3½ p.c. Red. Deb.	70—75	..	..
235,242	,,	Aug. 15	7½	8	Lea Bridge 5 p.c. Ord.	115—118	..	..
3,145,907	,,	Aug. 15	6½	6	Liverpool 5 p.c. Ord.	94—95b	+½	..
600,000	,,	Sept 26	7	7	Do. 7 p.c. Red. Pref.	99—101b*	..	..
166,766	,,	Aug 29	8	9	Maidstone 5 p.c. Cap.	122—127	..	..
69,480	,,	June 27	3	3	Do. 3 p.c. Deb.	53—56	..	..
75,000	5	June 13	†8	†10	Malta & Mediterranean	5½—6	..	..
392,000	—	Oct. 1	5½	5½	Metrop't'n (of Melbourne) 5½ p.c. Red. Deb.	96—99*	—2	96—96½
641,920	Stk.	May 30	†5	†9	Montevideo, Ltd.	105—108	..	..
2,051,815	,,	July 25	5½	5	Newcastle & Gateshead Con.	16/9—17/3d/	—·/3	..
682,856	,,	,,	4	4	Do. 4 p.c. Pref.	71½—72¾d	..	..
691,705	,,	June 27	3½	3½	Do. 3½ p.c. Deb.	68—69d	..	..
181,780	,,	Aug. 29	7/1/0	7½	North Middlesex 6 p.c. Con.	110—115	..	..
800,000	,,	Apl. 24	9	7	Oriental, Ltd.	113—118	..	..
205,162	,,	June 27	8	8	Plym'th & Ston'house 5 p.c.	110—113	..	..
424,416	,,	Aug. 29	8½	8	Portsm'th Con. Stk. 4p.c. Std.	113—118	..	..
241,446	,,	,,	5	5	Do. 5 p.c. max.	80—83	..	..
2,334,464	1	June 27	—	‡5	Primitiva Ord.	31/6—33/6	+·/6	31/9—32/10½
244,500	100	June 3	4	4	Do. 4 p.c. Red. Deb.	92—95	..	..
695,000	Stk.	July 25	4	4	Do. 4 p.c. Red. Deb. 1911	79—82	..	..
416,345	,,	June 27	4	4	Do. 4 p.c. Cons. Deb.	79—82	..	..
150,000	10	Sept. 26	6	6	San Paulo 6 p.c. Pref.	8½—9	+½	8 5/16—8 11/16
1,736,968	Stk.	Mar. 21	6½	6½	Sheffield Cons.	108—110e	..	..
95,000	,,	Jan 10	4	4	Do. 4 p.c. Deb.	74—77e	..	..
90,000	10	June 13	‡4	‡4	South African	4—6	..	..
6,609,895	Stk.	July 26	7½	5	South Met. Ord.	98½—100½	..	99½—100½
500,000	,,	,,	6	6	Do. 6 p.c. Irred. Pf.	106—109	..	106½—107½
1,895,445	,,	July 11	3	3	Do. 3 p.c. Deb.	54—57	..	..
784,000	,,	Sept. 12	5½	5½	Do. 5½ p.c. Red. Db.	98—100	..	..
91,500	,,	Aug 15	8½	8½	South Shields Con.	103—104d	..	..
1,548,795	,,	July 25	6½	6½	South Suburban Ord. 5 p.c.	102—105	..	103
468,837	,,	June 27	5	5	Do. 5 p.c. Deb.	95—98	..	..
647,740	,,	Aug 15	5	5	South'mpton Ord. 5 p.c. max	77—80	..	..
191,275	,,	June 27	4	4	Do. 4 p.c. Deb	70—73	..	..
179,014	,,	July 25	8	8	Sutton Ord.	116—119	..	..
67,828	,,	June 27	5	5	Do. 5 p.c. Deb.	90—93	..	..
250,000	,,	Feb. 21	7	7	Swansea 7 p.c. Red. Pref.	100—102	..	..
900,000	,,	June 27	6½	6½	Do. 6½ p.c. Red. Deb.	100—102	..	..
1,002,375	,,	Aug. 15	6¾	6¾	Tottenham District Ord.	105—108	..	..
150,000	,,	,,	5½	5½	Do. 5½ p.c. Pref.	97—100	..	..
181,355	,,	June 13	4	4	Do. 4 p.c. Deb.	74—77	..	..
389,094	,,	Aug. 29	7	7	Uxbridge, Maidenhead, & Wycombe 5 p.c.	93—98	..	..
88,880	,,	,,	5	5	Do. 5 p.c. pref.	85—90	..	..
80,000	,,	July 11	9	9	Wandsworth, Wimbledon, and Epsom— Wandsworth A 5 p.c.	135—140	—5	..
256,636	,,	,,	7½	7½	Do. B 5¼ p.c.	112—117	—5	..
439,585	,,	,,	6 3/16	6 3/16	Do. C and New	95—100	—3	..
852,000	,,	,,	7½	7½	Do. Wimbledon 5 p.c.	105—110	—5	105—109
98,000	,,	,,	7½	7½	Do. Epsom 5 p.c.	113—118	—5	..
200,000	,,	,,	5	5	Do. 5 p.c. Pref.	87—92	..	..
98,416	,,	June 27	3	3	Do. 3 p.c. Deb.	54—57	..	..
284,748	,,	,,	4	4	Do. 4 p.c. Deb.	74—77	..	..
267,500	,,	,,	5	5	Do. 5 p.c. Deb.	93—96	..	..

Quotations at:—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of Stock. * Ex. div. † Paid free of income-tax. ‡ For year.

Governor-General

GAS COOKER



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GENERAL GAS APPLIANCES LIMITED

Gaude Bridge Manchester.

COAL TRADE REPORTS.

From Our Own Correspondents.

NORTH-EAST COAST.

The market during the past week has shown improvement in most sections. The strength in Northumberland steams has been maintained, and the position is assured for some weeks ahead. With much better supply of boats, and rather stronger demand, Durhams are also firmer in tone than in recent weeks.

The better qualities of gas coal are reasonably well supplied with trade, and Wear Specials are firmly quoted at 17s. 6d. f.o.b. Best qualities are 16s. 6d. to 17s. Seconds are quoted at 15s. to 15s. 3d., and are firmer than of late. Coking coals report better inquiry, and are quoted steadier at 15s. 3d. to 15s. 9d. Durham bunker trade is irregular. Best qualities are round 15s. 6d. to 16s., but seconds are easy at 14s. 6d. to 15s. Northumberland steams are strong at 16s. to 16s. 3d. for best screened sorts.

Gas coke is strong, and quoted firmly at 24s. to 25s. f.o.b. for shipment.

YORKSHIRE AND LANCASHIRE.

The active demand for best hards continues both on prompt and forward account, and the output is scarcely equal to the demand. Values remain firm at 18s. to 18s. 6d. per ton. There is little change in the house coal trade; best qualities selling well. There is an improved request for gas coal. The inquiry for furnace coke remains steady, with values at 23s. to 24s. per ton f.o.b. Industrial fuel prices show little alteration, although there is a good inquiry for nuts and smalls.

The following are the Humber bunker and export prices, f.o.b. usual shipping ports:

South Yorkshire.—Hards, Association, bunkers 19s. 3d., export 18s. to 18s. 6d.; screened gas coal, export 18s. to 18s. 6d.; washed trebles, export 18s. to 18s. 6d.; washed doubles, bunkers 18s. 9d., export 17s. 6d. to 18s.; washed singles, export 16s. 6d.; washed smalls, bunkers 16s. to 16s. 3d.; export 15s.; rough slack, bunkers 13s. 6d. to 13s. 9d., export 12s. 6d. to 13s.; smithy peas, export 18s. 6d. to 19s.

West Yorkshire.—Hartleys, f.o.b. Goole, bunkers 17s. 6d., export 17s. to 18s.; screened gas coal, export 18s. to 18s. 6d.; washed trebles, export 18s.; washed doubles, export 16s. 3d. to 16s. 9d.; washed singles, export 16s.; washed smalls, bunkers 15s. 3d., export 14s. 6d.; unwashed doubles, export 17s. 6d.; unwashed doubles, export 15s. to 16s.; rough slack, bunkers 13s. 6d., export 11s. 6d. to 12s. 6d.; coking smalls, export 12s. 6d.

Derbyshire and Nottinghamshire.—Top hards, bunkers 19s. 3d., export 18s. to 18s. 6d.; cobbles, bunkers 18s. 9d., export 17s. 6d. to 18s. 6d.; washed trebles, export 18s.; washed doubles, export 17s. to 17s. 3d.; washed singles, export 16s. to 16s. 6d.; washed smalls, bunkers 15s. 3d. to 15s. 9d., export 14s. 6d.; unwashed doubles, export 16s.; rough slack, bunkers 13s. 3d. to 14s. 3d., export 12s. 6d.

Yorkshire, Derbyshire, and Nottinghamshire.—Screened steam coal, bunkers 17s. to 18s., export 16s. 6d. to 17s.; gas coke, export 22s. 6d. to 25s.; furnace coke, export, 23s. to 24s.; washed steam, Goole (West Yorks.), bunkers 17s. 9d.; Hull (West Yorks.), bunkers 18s.; Hull (South Yorks.), bunkers 18s. 3d., export 17s. per ton

MIDLANDS.

So far as the home market goes conditions are uncommonly flat. In the house coal trade, where seasonal advances of varying amount apply this month, sales have been very poor. Price revision has restored the lists of different districts to a more normal relation, the variableness of advances adjusting disparities which had arisen through differences of marketing policy during the summer months in the several areas.

Thus at Cannock Chase the associated collieries have put up prices of domestic fuel 2s. a ton, while in adjacent coalfields where previously the ascent had been accelerated the October increase is appreciably less. In the case of one Leicestershire grade the adjustment is downward. At some collieries which are outside the Five-Counties Scheme the September prices still hold good.

Business in slacks, "D.S." nuts, small nuts, annealing coal, steams, and industrial grades generally is still answerable to supply and demand. Work at the pits is very irregular. There is only a poor market for slacks and smalls such as are used under domestic boilers. Nevertheless the market remains comparatively free from surplus stocks. Medium grades command 6s. to 9s. "D.S." nuts have been coming forward faster than they could be absorbed. A few spot lots have been on offer at special prices. The general level is indicated by 9s. to 12s. 6d., though some pits quote more. Bakers' nuts have been in comparatively good demand at 18s. upwards.

CONTRACTS OPEN.

Coal Gas Plant.

The Teignmouth Urban District Council Gas Department invite tenders in connection with the extension of their coal gas plant. [See advert. on p. 126.]

Pipes and Specials.

The Gas Committee of the Marple Urban District Council invite tenders for the supply of cast-iron pipes and specials. [See advert. on p. 126.]

Great Interest Abroad for the "Achema VI."—Full attention is being paid to all particulars regarding the Exhibiton of Chemical Apparatus, "Achema VI.," organized by the "Deutsche Gesellschaft für Chemisches Apparatewesen E.V.," which will take place at Frankfort-on-the-Main from June 10 to 22, 1030. There have been conferences recently with the Japanese Commercial Attaché in Berlin, and it is reported that representatives of the Japanese chemical industry will visit the exhibition.

The "Victory"

PREPAYMENT METER

WITH

PLATE PRICE CHANGER

OUTSIDE VALVE BOX

EVERY PART INTERCHANGEABLE

MADE BY

THE PIONEERS

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SAWER & PURVES

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MILES PLATTING, RADFORD ROAD,

MANCHESTER NOTTINGHAM

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UNDISPLAYED ADVERTISEMENTS: Situations Wanted, Six Lines and under (about 36 words), 3s.; each additional Line, 6d. Situations Vacant, Apparatus Wanted and for Sale, Contracts, Public Notices, &c., 9d. per Line—minimum, 4s. 6d. An additional charge of 6d. is made where replies are addressed c/o the "JOURNAL."

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THE "GAS SALESMAN."

The "GAS SALESMAN" is included as a supplement to the "JOURNAL" eighteen times a year—twice a month from October to March, and once a month from April to September. Additional copies are also obtainable at the following rates: Annual Subscription **6/-**, post free, payable in advance. Single copies (by post) **4½d.** In Bulk for Distribution among Gas Service Staffs—100 copies of each issue, **30/-**; 50 copies, **16/-**; 25 copies, **8/-**; 12 copies, **4/-**, all plus carriage.

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(See also advertisement, p. 81.)

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(See illustrated page advert. Centre p. XI., Sept. 25).

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Tins for Sale to Consumers.
In Bulk for Works Use.
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Representation in New Zealand already provided for.

Apply, JOYMANCO (BRIGHTON), LTD., CAMBRIDGE GROVE, HOVE, ENGLAND.

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There are at present 18,000 incandescent gas lights, about 10,000 electric lights, including those in Municipal buildings, besides a number of oil lights. Additions are being made every year. Gas and electricity are supplied by public companies; but the Corporation are considering the question of providing their own electric generating station. The Lighting Department of the Corporation are responsible for the maintenance of the public street lamps and also of about 3,000 lights and 800 electric fans in Municipal Buildings.

Candidates must have recent experience of street lighting by gas in a large city with a thorough and up-to-date knowledge of mantles, burners, &c., photometric work, testing pressure, gas analysis, calorific value, and determining the discharging capacity of burner nipples. Candidates must also have similar knowledge of street lighting by electricity and of the working of generating station and possess certificates from recognised institutions or large Municipalities that they possess a thorough knowledge of street lighting by gas and electricity and are capable of managing and controlling the Lighting Department of a large city.

The appointment is subject to the Provident Fund, Leave, and other Service Rules of the Corporation and may be terminated at any time by three months' notice on either side. The Provident Fund contribution is 8⅓ per cent. of the monthly salary and an equivalent amount is added by the Corporation, and the fund accumulates at compound interest. The selected candidate will be required to devote his whole time to the duties of his office and will not be allowed to take up any outside work. He will be liable to removal during the term of his office for misconduct or neglect of or incapacity for his duties. He will be required to submit to a medical examination and produce a certificate of physical fitness before joining his appointment. If a candidate is selected outside India, the Corporation will pay his passage (1st class) from London to Calcutta and also half pay for the period occupied by the journey, but he must refund the amount paid for passage if he gives notice within two years from the date of taking up his appointment. He will be required to take up his appointment about the 1st March, 1930.

Candidates should state their Age and Experience. In case a candidate is related to the Mayor, or any Alderman or Councillor or any Statutory Officer of the Corporation, he should notify such relationship in his application.

Applications will be received by the Secretary to the Corporation of Calcutta, Central Municipal Office, Calcutta, up to Friday, the 15th November, 1929.

B. V. RAMIAH,
Secretary to the Corporation.

Central Municipal Office,
The 11th September, 1929.

WANTED — Draughtsman. Accustomed to Bye-Product Plant Pipework.

Reply, by letter, giving full details of Experience, &c., to the COPPÉE CO. (G.B.), LTD., 44, GROSVENOR PLACE, S.W. 1, marking envelope "Draughtsman."

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ENGINEER seeks responsible Position, fully qualified in all Gas Production Plants, Electric or otherwise; also Carbonizing and Products.

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GASHOLDER.—Spiral Guided 100,000 c.ft. cap. with Steel Tank. Excellent condition; re-erected cheap.

Purifiers—Dry Lute Type. One Set of Four, 10 ft. square; One Set of Two, 10 ft. square; and One Set of Two, 8 ft. square, with Lifting Gear Valves, &c.

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CONTRACTS OPEN.

MARPLE URBAN DISTRICT COUNCIL.
(GAS DEPARTMENT.)

"PIPES AND SPECIALS."

THE Gas Committee invite Tenders for the Supply and Delivery, f.o.r. Marple Station, of S. & F. Open Joint C.I. (Vertically Cast) PIPES, also SPECIALS, to British Standard Specification Class B, coated with Dr. Angus Smith's solution.

Tenders to state effective Length, Weight per Pipe, and date of delivery.

Lengths of Pipes required:

112 yards of 18 inches internal diameter.						
69	,,	,,	15	,,	,,	,,
38	,,	,,	12	,,	,,	,,
7	,,	,,	10	,,	,,	,,
300	,,	,,	6	,,	,,	,,

The lowest Tender not necessarily accepted, and the Contractor will be required to enter into a Contract to be prepared by the Clerk to the Council.

Sealed Tenders, made out on Contractors' own Forms, endorsed "Pipes," and addressed to the Chairman of the Gas Committee, Council Offices, Marple, near Stockport, must be delivered not later than 12 o'clock noon, on Saturday, the 19th of October, 1929.

JAMES FREEMAN,
Clerk to the Council.

Council Offices,
Marple,
Oct. 7, 1929.

TEIGNMOUTH URBAN DISTRICT COUNCIL.
(GAS DEPARTMENT.)

TENDERS are invited for the Extension of the COAL GAS PLANT at the Gas-Works belonging to the above Council.

Drawings and Specification may be obtained on application to the undersigned.

Tenders to be delivered by Saturday, Oct. 26.

H. HIGHAM,
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Gas-Works,
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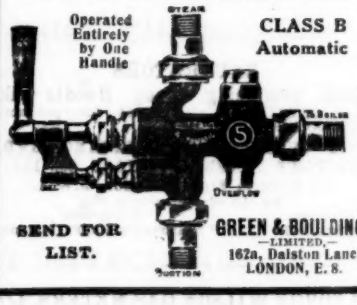

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